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THIRTY-FIRST ANNUAL REPORT

OF

THE LOCAL GOVERNMENT BOARD,

1901–02.

SUPPLEMENT

CONTAINING THE

REPORT OF THE MEDICAL OFFICER

For 1901–02.

Presented to both Houses of Parliament by Command of His Majesty.

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ANNUAL REPORT

OF THE

MEDICAL OFFICER

OF

THE LOCAL GOVERNMENT BOARD

FOR THE YEAR

1901 02.

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REPORT.

MEDICAL OFFICER'S REPORT.

TO THE RIGHT HONOURABLE WALTER HUME LONG, M.P., PRESIDENT OF THE LOCAL GOVERNMENT BOARD.

SIR,

I HAVE the honour to submit a record of the work carried on in the Board's Medical Department in 1901–02.

VACCINATION AND PUBLIC VACCINATION.

In Appendix A, Nos. 1 and 2, are summaries, in continuation of previous records, of Vaccination Officers' Returns for the years 1899 and 1900. For England and Wales as a whole the data thus afforded compare not unfavourably with those for 1898, the year in which the new Vaccination law was enacted, as is illustrated by the following figures :—

England and Wales.

Year.	Births.	Vaccinated.	Insusceptible.	Had Small-pox.	Exempted.	Died Unvaccinated.	Postponed.	Remaining.	Not accounted for (including cases postponed) per cent. of Births.
1898 ..	923,059	562,737	3,232	4	47,423	110,912	16,921	181,830	21·5
1899 ..	929,189	617,113	5,379	4	33,573	113,516	16,605	142,999	17·2
1900 ..	937,222	636,940	2,261	2	39,600	103,538	14,225	130,557	15·6

The figures in the last column of this table give statistical information regarding obedience to the Vaccination laws, but they do not now as formerly afford accurate measure of abstention from infantile vaccination. The parent obtaining in respect of the vaccination of his infant a certificate of "conscientious objection" and the parent securing a certificate of successful vaccination alike satisfy the law, and for routine statistical

purposes their children are "finally accounted for." The effect, however, of their diametrically opposed procedures must needs be taken account of statistically if the degree to which infantile vaccination loses or gains acceptance in the present is to be compared with its observance in the past. Accordingly, Appendix A, No. 3, has under my supervision been compiled by the clerical staff of the Medical Officer's Department. In these statistics "exempted" infants are classed with infants "postponed," removed, and otherwise unaccounted for; so that comparison may be instituted, on the percentage of births in each instance, between periods of time before and after enactment of the new law, as to amounts of vaccination and of non-vaccination among infant populations. The areas thus dealt with comprise England and Wales, the Metropolis, the several Counties, and each separate Union throughout the country; while the periods of time selected for comparison are the five years 1893–97 antecedent to enactment of the new vaccination law, the year 1898 in which the Act was passed, and the succeeding years 1899 and 1900.

These statistics suffice to show that rejection by parents of infantile vaccination, which had steadily increased while the Royal Commission on Vaccination continued its labours, culminated in 1898 in the maximum so far observed of abstention from statutory vaccination; and that thereafter, under the new law enacted in that year, acceptance of infantile vaccination began generally and for the most part largely to increase. For England and Wales as a whole, and for the Metropolis as contrasted with the rest of the country, the following figures illustrate these facts:—

—	Percentage of Births in each instance remaining unvaccinated in—			
	1893–97.	1898.	1899.	1900.
England and Wales ...	21·0	26·6	20·8	19·9
" less Metropolis ...	20·5	25·4	19·4	18·7
Metropolitan Unions ...	23·9	34·4	28·7	26·8

Except as regards the Metropolis, there is here seen in 1900 less abstention from infantile vaccination than in the five years preceding enactment of the new law. And Metropolis and country alike show a conspicuous improvement since 1898.

Scrutiny in like fashion of the records county by county reveals similar very general decrease of abstention from infantile

vaccination in 1900 as compared with 1898. Of 54 counties of England and Wales no less than 50 have improved in this sense; only four had more abstentions in 1900 than in 1898. There are, however, too many counties like London, in which the proportion of abstention from infantile vaccination has not yet been reduced to that of the five years antecedent to enactment of the new law. Counties in this unsatisfactory category, though less numerous than those which have followed the lead of England and Wales as a whole, number 21 out of the total 54 county divisions under consideration.

Passing now to separate units of vaccination administration, namely Unions, Metropolitan vaccination authorities deserve special attention in view of the disadvantageous position of London as compared with the rest of the country in the matter of protection against small-pox of its child population. Though the Metropolis, as a whole, has exhibited since 1898 increasing acceptance of infantile vaccination, it remained in 1900, as regards percentage of births vaccinated, far behind the rest of the country. And further, London exhibited in 1900 an amount of abstention from vaccination greater even than in the five years antecedent to enactment of the new law. In 1893–97 abstention from vaccination in the Metropolis amounted to 23·9 per cent. of the births; in 1900 the figures were 26·8 per cent. To this unsatisfactory state of affairs most of the 31 Metropolitan Unions contributed; but chief among offenders were 11 unions—Mile End, Shoreditch, Bethnal Green, Poplar, Stepney, Hackney, St. Giles, St. George-in-the-East, St. Pancras, Holborn, and Southwark—all of which presented in 1900 a degree of abstention from infancy vaccination in excess of the mean for the Metropolis.

These unions are referred to as "offenders" for the reason that abstention from vaccination in the Metropolis in 1900 was almost wholly without legal warrant. In no single union did "certificates of conscientious objection" amount to 3 per cent. of the births, while in three only of the 11 unions above named did objection of this sort exceed 1 per cent. Obviously in London, in 1900, defect of protection of infants against small-pox was due, not to "conscientious objection" on the part of parents, but to neglect by those persons of the duties imposed on them by the legislature, and above all to default of vaccination authorities and their officers in enforcement of the law.

As in London, so in the Provinces, particular unions and groups of unions have been responsible for degradation, statistically, of whole counties in the matter of infantile vaccination. Conspicuous among counties thus rendered especially susceptible to small-pox in their child population are Leicester, Bedford, Northampton, Derby, Wilts, Gloucester, and Radnor; all of which

exhibit in 1900 births "not vaccinated" in proportions exceeding 30 per cent. But among the unions constituting counties thus unfavourably circumstanced to resist epidemic small-pox there is not observed, as is largely the case in the Metropolis, uniform disregard of the law. Not all of these provincial unions have, as have many London unions, abstained alike from vaccination and from "conscientious objection." In the Provinces, and often within the limits of the same county, there are to be found unions liable to small-pox among their infants in diametrically opposite circumstances; unions, that is, in which parents have satisfied the law largely by obtaining exemption certificates, and unions in which parents, by connivance very often of the guardians, have been by way of disregarding the law altogether. The sole redeeming feature of the statistics in this connexion is the fact that in unions of both classes, and especially in unions prone to exemption certificates, infantile vaccination has since 1893-97 commonly become increasingly accepted. In illustration of the divergent conditions of administration associated with large abstention from vaccination I submit the following data in respect of the seven counties named above, and certain unions therein :—

Leicester (11 Unions).

Per cent. of Births in 1900 in each instance.

——	Total not Vaccinated.	"Exempted."	Not accounted for.
County	*64·6*	*21·0*	*42·7*
Leicester	78·7	9·6	69·1
Barrow-on-Soar	68·7	43·5	25·2
Loughborough	65·6	43·9	21·7
Hinckley	54·1	33·0	21·1
Market Bosworth... ...	51·8	41·4	10·4
Market Harborough ...	44·7	37·6	7·1

In all the above Unions, except Market Bosworth, infantile vaccination has increased since 1893-97; in some of them largely.

Bedford (5 Unions).

Per cent. of Births in 1900 in each instance.

—	Total not Vaccinated.	"Exempted."	Not accounted for
County	*59·6*	*20·2*	*39·4*
Luton	79·9	31·0	48·9
Bedford	72·1	1·1	71·0
Leighton Buzzard... ...	44·6	37·4	7·2
Ampthill	32·8	21·7	11·1
Biggleswade	26·5	22·6	3·9

In all these Unions, except Bedford, infantile vaccination has increased since 1893–97 ; in most of them largely.

Northampton (12 Unions).

Per cent. of Births in 1900 in each instance.

—	Total not Vaccinated.	"Exempted."	Not accounted for.
County	*55·7*	*15·9*	*39·8*
Wellingborough	78·8	10·9	67·9
Northampton	76·2	22·1	54·1
Kettering	71·1	13·4	57·7
Thrapston	53·5	46·5	7·0
Towcester	46·3	30·5	15·8
Hardingstone	43·9	33·6	10·3
Brixworth...	38·3	5·6	32·7
Daventry	33·9	12·3	21·6
Brackley	33·5	10·8	22·7
Potterspury	31·1	27·3	3·8

In all these Unions, except Potterspury, infantile vaccination has increased since 1893–97 ; in some of them very largely.

Derby (9 Unions).

Per cent. of Births in 1900 in each instance.

—	Total not Vaccinated.	"Exempted."	Not accounted for.
County	*36·6*	*3·5*	*33·1*
Derby	71·4	2·0	69·4
Shardlow	39·9	4·0	35·9
Glossop	33·9	20·0	13·9

In Derby and Glossop infantile vaccination has increased since 1893–97; in Glossop very considerably.

Wilts (17 Unions).

Per cent. of Births in 1900 in each instance.

—	Total not Vaccinated.	"Exempted."	Not accounted for.
County	*35·8*	*20·3*	*15·5*
Trowbridge and Melksham	66·2	12·8	53·4
Swindon and Highworth...	47·7	37·6	10·1
Chippenham	47·5	12·9	34·6
Bradford-on-Avon ...	43·0	7·7	35·3
Devizes	39·4	30·6	8·8
Calne	39·3	11·8	27·5
Cricklade and Wootton Bassett.	35·7	25·9	9·8

Infantile vaccination increased considerably in two out of the three Unions showing highest ratio of exemption; decreased, sometimes largely, in most of the others.

Gloucester (17 Unions).

Per cent. of Births in 1900 in each instance.

——	Total not Vaccinated	"Exempted."	Not accounted for.
County	*34·7*	*9·4*	*25·3*
Tewkesbury	67·0	23·3	43·7
Gloucester	57·1	20·8	36·3
Stroud	54·2	19·3	34·9
Westbury-on-Severn ...	49·8	39·2	10·6
Wheatenhurst	40·0	14·8	25·2
Cheltenham	39·1	19·5	19·6
Bristol	31·4	2·4	29·0
Dursley	31·0	20·4	10·6

In all the above Unions, except Tewkesbury and Bristol, infantile vaccination has increased since 1893–97 ; in some of them largely.

Radnor (2 Unions).

Per cent. of Births in 1900 in each instance.

——	Total not Vaccinated.	"Exempted."	Not accounted for.
County	*33·2*	*2·5*	*30·7*
Rhayader	50·8	0·4	50·4
Knighton	19·3	4·1	15·2

In Rhayader infantile vaccination has diminished, whereas in Knighton it has increased nearly 50 per cent. since 1893–97.

In addition to the above 41 unions (out of 616 extra-metropolitan unions in England and Wales), I have abstracted from Appendix A, No. 3, other 49 unions wherein, as in the seven counties already dealt with, births "not vaccinated" in 1900 exceeded in each instance 30 per cent. These 49 unions divide into two groups of 22 and 27 unions respectively, according as their abstention from vaccination was in the main due to registered "conscientious objection" or to mere neglect and carelessness resulting in disobedience to the law. Certain facts, numerically for each group, are set out statistically in the subjoined tabular statements :—

Twenty-two Unions having upwards of 30 per cent. of Births "not vaccinated" in 1900, and showing in that year a higher percentage of Exemption than of Default.

Number of Unions.	Exemption.		Default.		Increase or Decrease of Vaccination since 1893–97.					
					Unions showing Increase.			Unions showing Decrease.		
	Mean.	Range.	Mean.	Range.	Number.	Mean.	Range.	Number.	Mean.	Range.
22 *	28·6	16·7 to 53·6	11·1	1·8 to 23·0	20	20·6	1·7 to 49·8	2	10·7	3·2 to 18·2

* Wycombe, Winslow, Amersham, Orsett, St. Albans, Tonbridge, Oldham, Bury, Gainsborough, Glanford Brigg, Spalding, Norwich, Haltwhistle Banbury, Lewes, Uckfield, Hailsham, Newhaven, Scarborough, Keighley, Skipton, Saddleworth.

Twenty-seven Unions having upwards of 30 per cent. of Births "not vaccinated" in 1900, and showing in that year a higher percentage of Default than of Exemption.

Number of Unions.	Default.		Exemption.		Increase or Decrease of Vaccination since 1893–97.					
					Unions showing Increase.			Unions showing Decrease.		
	Mean	Range.	Mean.	Range.	Number.	Mean.	Range.	Number.	Mean.	Range.
27 †	35·6	17·4 to 68·1	8·4	0·6 to 24·2	15	15·3	1·7 to 43·7	12	12·8	0·3 to 41·3

† Reading, Cockermouth, Gateshead, West Ham, Gravesend and Milton, Burnley, Rochdale, King's Lynn, Castle Ward, Morpeth, Mansfield, Basford, Keynsham, Axbridge, Bridgwater, West Bromwich, Burton-upon-Trent, Wolverhampton, Ipswich, Eastbourne, East Grinstead, Rugby, Atherstone, Coventry, Nuneaton, Halifax, Dewsbury.

MEDICAL OFFICER'S REPORT.

These data show once again that a high degree of abstention from infantile vaccination, whether due in the main to "conscientious objection" or to carelessness and neglect, has nevertheless, in the majority of the unions in question, been accompanied by an increase in the amount of vaccination performed since 1898. And further, they tend to indicate, as before, that such increase of infantile vaccination has been on the whole greater where hostility to vaccination is frankly proclaimed in the manner provided for by the law than in unions merely neglectful or indifferent to the law's requirements.

It is thus seen that the existence in a particular community of widespread hostility to vaccination need not necessarily be accompanied by neglect of vaccination due to mere carelessness or apathy of parents or of vaccination authorities and their officers; that in fact, disposition on the part of a given population to avail itself of legalised exemption from vaccination is by no means incompatible with growing acceptance of vaccination among that population.

Conversely, mere neglect or unreasoning disobedience to the law does not necessarily imply hostility to vaccination. In Appendix A, No. 3, where the data for 1900 are given for 54 counties of England and Wales, it will be found that no less than 36 of the counties exhibit a proportion of "abstention" from vaccination exceeding in each instance 10 per cent. of the births. It is certain that in most of these 36 counties this fact is less evidence of rooted and widespread objection to vaccination than of carelessness and neglect of duty on the part of parents and of vaccination authorities. From the same Appendix it will be seen that there are only 11 counties in which, during 1898, 1899, and 1900, "conscientious objection" has been in excess of 10 per cent. of the births. And the counties in question—Bedford, Buckingham, Dorset, Gloucester, Leicester, Lincoln, Norfolk, Northampton, Nottingham, Oxford, and Wilts—comprise, almost without addition, all those county areas in which antecedent to the Vaccination Act of 1898, and antecedent also to the appointment of the Royal Commission on Vaccination, organised objection to compulsion had been especially rife. The topographical distribution of hostility in this sense to vaccination has in fact altered little since pre-Commission days. Certain studies by Mr. C. J. Huddart, Assistant Inspector in the Medical Department, in this connexion are interesting. In Appendix A, No. 4, he furnishes a memorandum with an associated series of maps, on "default" by counties* under the Vaccination Acts in the 28 years 1873–1900. His data and illustrations comprise five successive quinquennia between 1873 and 1897, and as well, each of the succeeding years 1898, 1899, and 1900. The outcome of Mr. Huddart's study serves to emphasise the slow growth in counties of any general disposition to abstention

* For the purposes of Appendix A, No. 4, Wales has been regarded as containing two counties only, *i.e.*, North and South Wales.

from infantile vaccination, and, as regards the country as a whole, the small topographical range at any time of deliberate and sustained disobedience to the vaccination laws. The facts which he records in much detail may be conveniently summarised in the form of tabular statements A, B, and C.

A.

Default per cent. of Births.	Counties showing cases "not finally accounted for," in successive quinquennia.				
	1873–77.	1878–82.	1883–87.	1888–92.	1893–97.
0–5	37	34	28	8	1
5–10	8	11	16	18	9
10–20	—	—	—	16	17
20–30	—	—	1°	—	12
30–50	—	—	—	2†‡	3
50 + ...	—	—	—	1*	3*†‡

B.

Abstention from Vaccination per cent. of Births.	Counties showing abstention from vaccination (inclusive of legally exempted cases) in 1898 and in succeeding years.		
	1898.	1899.	1900.
0– 5	—	—	1
5–10	5	8	8
10–20	10	19	19
20–30	18	11	11
30–50	9	4	3
50 + ...	3°†‡	3°†‡	3*†‡

° Leicester. † Bedford. ‡ Northampton.

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C.

"Conscientious Objection" per cent. of Births.	Counties showing legally exempted cases ("Conscientious Objections") in 1898 and in succeeding years.		
	1898.	1899.	1900.
0–5	27	30	27
5–10	7	7	10
10–20	9	8	5
20–30	1*	—	3*†§
30–50	1‡	—	—
50 + ...	—	—	—

* Leicester. † Bedford. ‡ Northampton. § Wilts.

Table A shows for the 15 years, 1873-87, antecedent to appointment of the Royal Commission on Vaccination, steadily growing neglect of infantile vaccination in counties, though amounting in none but a single instance (Leicester) by the end of the 15 years, to default exceeding 10 per cent. of the births. Also the table shows in the next five years, 1888-92, the Royal Commission having commenced to take evidence in the second year of the period, a somewhat sudden increase of infantile vaccination default in many counties; a retrogression statistically which became greatly enhanced in the following five years, 1893-97, during which the Commission completed its labours and issued its final report.

Table B shows for the single year 1898, that year in which, the vaccination question having been under discussion in Parliament, the new vaccination law was enacted, a still further retrogression of counties in the direction of infantile vaccination default. But also this table shows for the following year, 1899, that in which the new Act came into force, a distinct diminution among counties of abstention from infantile vaccination, a reversion toward better observance of the law which it is seen was fully maintained in the next succeeding year, 1900.

Table C shows that in the three years, 1898-1900, such abstention in counties from infantile vaccination as continued to be maintained resulted chiefly from neglect and carelessness; that in very small degree was it referable to "conscientious

objection," and that excess of objection of this sort was practically limited as of old time to a few counties, for instance, Leicester, Northampton, Bedford, and Wilts.

MEDICAL OFFICER'S REPORT.

INSPECTION OF PUBLIC VACCINATION.

The number of Unions inspected in 1901 in regard of vaccination amounted to 235, comprising 1,215 Public Vaccinators' districts. The Public Vaccinators of 855 of these districts were recommended for award under Section 5 of the Vaccination Act of 1867 (Appendix A, No. 5).

EDUCATION IN VACCINATION.

In Appendix A, No. 6, will be found a list of Educational Vaccination Stations, with the names and addresses of the Teachers of Vaccination authorised, under Orders of the Board, in England and Wales, Scotland, and Ireland to grant the special certificates of proficiency in vaccination necessary as part of the medical qualification for entering into contracts for the performance of public vaccination.

ANIMAL VACCINE ESTABLISHMENT.

The Director of the Animal Vaccine Establishment, Mr. Thomas S. Stott, reports (Appendix A, No. 7) that during the year ending 31st March, 1902, the number of primary vaccinations performed at the Board's station in Lamb's Conduit Street amounted to 2,786. In the same period re-vaccinations at this station numbered 1,045. These figures are in each instance in excess of those of recent years owing to the presence of epidemic small-pox in London. Throughout the year primary vaccination was afforded at the station to all applicants, but in time of extra pressure by small-pox it was necessary to refer many persons seeking re-vaccination at Lamb's Conduit Street to the Public Vaccinators of the districts in which they were residing.

GLYCERINATED CALF LYMPH AND NATIONAL VACCINE ESTABLISHMENT.

The London small-pox outbreak in the autumn of 1901, which speedily developed into an epidemic affecting not only the Metropolis but also certain of the home counties, and even more distant localities, cast a very severe strain on the Board's lymph manufacturing and lymph distributing establishments. As a consequence of the Board's desire to furnish public vaccinators with lymph for re-vaccinations as well as for the primary vaccinations for which the Board accept particular responsibility, these establishments had to be repeatedly amplified and extended, not only in the matter of staff but also as regards housing, laboratory accommodation, and calf stabling. As early as October, 1901, additional calf stables in the neighbourhood of Lamb's Conduit Street had to be acquired at short notice, and these were further extended in January. At the latter date, extra laboratories were, on emergency and by special arrangement, placed at the Board's disposal by the Jenner Institute of Preventive Medicine. Later on further calf stabling became requisite, and this had to be provided separately at Peckham. Despite, however, the above efforts of the Board to keep pace with the rapidly increasing demands, under panic of small-pox, of London and country for lymph to be employed generally in the vaccination of infants, but more especially

in the re-vaccination of older persons, a time was not long in arriving when the Department could no longer bear the excessive strain thus put upon it. After distributing in successive weeks 22,918, 47,891, and 80,417 charges of glycerinated calf lymph it became imperative on the Board, if the lymph furnished by them was to remain not only active but uniformly free from extraneous micro-organisms, to put some limit on their issue weekly of this preventive of small-pox. Accordingly from the end of January, 1902, until early March, though all Public Vaccinators continued to be duly supplied with the lymph required by them in infantile vaccination, issue of glycerinated calf lymph for re-vaccination purposes had to be restricted to the Public Vaccinators of districts in which small-pox was actually prevailing. Nevertheless, in the complete year ending 31st March, 1902, the Board was able to issue no less than 974,595 charges of glycerinated calf lymph, all of it of excellent quality, as was proved in regard of near a million individuals, by a recorded "insertion success" of 93·5 per cent. in the case of primary, and of 92·9 per cent. in the case of secondary vaccination.

In Appendix A, No. 8, will be found Dr. Blaxall's report on the above operations of the establishment under his charge; and in Appendix C are papers by Dr. Blaxall, Mr. Fremlin, and Dr. Alan Green on calf lymph in certain of its etiological and biological aspects. Upon these observations of the Board's staff at the lymph laboratories I shall be commenting at a later stage of this report.

General Administrative Business of the Medical Department.

Wider diffusion of knowledge in sanitary matters, and new developments of epidemiological research, lead year by year to increased demand for administrative action to safeguard the public health, and give ever growing importance to the right determination of the lines which such action should follow. Hence the subjects on which the Medical Department finds itself called upon to give expert advice yearly become more numerous, while, as a result of increased experience, individual questions necessarily assume greater complexity in their administrative as well as in their scientific aspects.

Many conferences have been held at the office with representatives of local authorities, notably on such matters as hospital construction, local byelaws, and appointment of officers. As heretofore, the information at the disposal of the Medical Department has also been freely sought by experts and administrative officers of various public bodies, and advantage has been derived from interchange of experience with medical officers of health and others concerned with questions of disease prevention.

Much benefit has also accrued from informal discussions and conferences on various subjects between Medical Inspectors and local authorities or their officers. This has been particularly noteworthy in respect of administration directed to the control of small-pox, where it is essential that the work of the various authorities and officers concerned—Boards of Guardians, Town or District Councils, and Hospital Authorities—should be co-ordinated as far as possible, and be shaped towards the common end of preventing the spread of the disease. Medical Inspectors have also in numerous instances held formal inquiries in such matters as combination of districts for hospital purposes, loans for hospital sites and buildings, and demands for public scavenging, while in a few instances special subjects for inquiry have arisen in which it has been considered desirable that a Medical Inspector should be associated with officers of other departments of the Board for the purpose of a joint investigation.

In Appendix A, No. 9, will be found a summary of the total work of the Medical Inspectors in the directions above indicated. Reports of detailed inquiries which Inspectors of the Medical Department have undertaken during the year in 26 districts on account of outbreaks of infectious disease, or of defective sanitary administration, are abstracted in Appendix A, No. 10, and certain of them, which afford particularly instructive illustration of conditions of disease prevalence, or of the sanitary shortcomings which not unfrequently call for the Board's intervention, are reproduced in Appendix A, Nos. 11-16, of this volume.

MAL-ADMINISTRATION, WEYMOUTH.

Sanitary administration at Weymouth, a well known health resort with a population of nearly 20,000, appears from a report by Dr. Sweeting (Appendix A, No. 11) very far from satisfactory. Especially as regards control of infectious disease, notably scarlatina, have administrative shortcomings of the Borough become prominent as a result of Dr. Sweeting's inquiry. Briefly the facts are these. The late Medical Officer of Health of Weymouth, fortified by a particular clause of a Local Improvement Act, and in laudable desire to procure hospital isolation of all cases of scarlatina in the place, acted commonly with excess of zeal ; his proceedings in securing isolation became, indeed, so trenchant as to produce something of a revolt against his administration generally, and in circumstances as follows :—The Weymouth Town Council do not possess an isolation hospital of their own. For some years, however, they have had an arrangement with the Weymouth Port Sanitary Authority to make use of the Port Hospital at a fixed rate of payment for cases of infectious disease admitted from the Borough. This Port Hospital, which is well situated, provides accommodation for twenty-five patients. But during the outbreak in Weymouth of the scarlatina which brought about Dr. Sweeting's

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inquiry, as many as seventy-two patients were at one time "accommodated" within the establishment. Thus it happened that on a particular occasion a ward, intended for six but into which twice that number of beds had been introduced, was made to contain twenty-one patients, several being two in a bed. Parallel with overcrowding in this way of patients there occurred breakdown of hospital administration in other ways owing to the establishment being under-nursed and under-staffed generally; and as a consequence patients who in effect had been compulsorily removed to hospital were called upon to empty bed pans, to remove slops, and to perform other menial work in connexion with the establishment. The sole satisfactory feature of the scandal which thus arose has been inauguration, through the publicity attaching to Weymouth's mal-administration, of a better state of affairs, not only as regards hospital equipment and management but also in public health administration generally.

FALMOUTH.

For several years the inefficient sanitary administration of the Town Council of Falmouth has from time to time claimed the Board's attention. In 1899, for instance, in view of a serious prevalence of enteric fever in the borough, Dr. Buchanan was directed to make inquiry into the circumstances of the outbreak, and as to the administrative procedures of the authority. The condition of affairs which Dr. Buchanan's report revealed was very far from satisfactory. His report was printed and communicated to the Falmouth Town Council. Correspondence which ensued failed to satisfy the Board that the local authority was taking a sufficiently high view of its obligations with reference to the health of its district; and accordingly Dr. Buchanan was directed to revisit the town for the purpose of ascertaining what steps had been taken by the authority to act on the recommendations contained in his 1899 report. This re-inspection of the district was carried out in the autumn of 1901, and Dr. Buchanan's report thereon is reproduced in Appendix A, No. 12. From this further report it will be seen that since 1899 some good work, particularly in regard of obtaining improvement in the sanitary condition of dwellings, could be put to the credit of the Town Council, and that this authority had "shown considerably greater activity in sanitary matters than was formerly the case." But also the report shows that much important work still remains to be done; that the Town Council should not remain content with the progress that recently has been made. In view of the serious pollution by sewage of the foreshore of Falmouth harbour, it is to be regretted that at the date of writing little progress has been made with the scheme for sewage disposal which the Town Council had decided to adopt at the time of Dr. Buchanan's re-inspection. It must also be regarded as unfortunate that a decision of the Town Council to purchase the undertaking of the local Waterworks Company, with a view to effecting a

comprehensive improvement in the conditions of supply, was not endorsed by the ratepayers; the more since Dr. Buchanan's report serves to show that opportunities of pollution on the gathering ground still remain, that the method of filtration adopted by the Water Company continues to be faulty, and that insuction through leaky pipes in back yards and passages is still liable to occur. In this connexion, indeed, Dr. Buchanan's report illustrates once again the relatively helpless condition of a town, the water supply of which is governed by a company which is unable or unwilling to take adequate steps to safeguard the purity of the water which it delivers.

ENTERIC FEVER, FOLKESTONE.

Folkestone has not been in former years specially prone to enteric fever; it has suffered indeed in that respect far less relatively than many other towns. But in 1896-1900 there occurred definite increase of this disease in the town and under circumstances topographically and administratively of no little complexity. Attempt at elucidating this problem necessarily involved Dr. Theodore Thomson, who was charged with the inquiry, in a prolonged investigation, notwithstanding that his inquiries were facilitated by the circumstance that record had been preserved of carefully observed facts in connexion with the fever by the officers of the local authority. Too often it happens that the services of the Board's expert staff in regard to epidemic disease are invoked by localities in which little, if any, care has been exercised in observing and recording facts requiring explanation.

The evidence collated, duly weighed, and dealt with by Dr. Thomson leaves little doubt that a considerable proportion of the extra enteric fever which appeared in Folkestone in the period 1896-1900 is to be ascribed to specifically infected milk, though as regards the particular year 1898 the data available point less definitely in this direction than in certain other years. However this may be there can be no question that the facts adduced by Dr. Thomson show a particular strain of milk, which he terms A X milk, to have been not only in 1899 an active agent in disseminating enteric fever but to have again exhibited that property, though in diminished degree, in the next succeeding year 1900.

But, as has been indicated, specifically contaminated milk is not in Dr. Thomson's view to be regarded as more than mainly responsible for increased incidence of enteric fever on Folkestone in 1896-1900. He notes that after deduction of "imported cases," of cases in all probability referable to milk, and of cases due perhaps to shell-fish, there remains for the period in question an amount of enteric fever in excess of that of antecedent years. And, in endeavouring to account for the facts witnessed, he considers a number of conditions—chief among them defects of the sewerage and drainage system of the place in their relation to

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soil pollution—which possibly may have given to the enteric fever bacillus, introduced to Folkestone in considerable amount in 1896 (and multiplied there in milk in subsequent years), opportunity of becoming acclimatised to, and so to speak indigenous in, the soil of the place. In these and in other aspects Dr. Thomson's report (Appendix A, No. 13) is an admirable example of thorough (so far as our knowledge at present extends) and painstaking epidemiological study.

As regards sanitary administration in Folkestone, Dr. Thomson, while giving due credit to the local authority for the improvements they have in recent years effected in the condition of their district, points out the need not only for continuance of their efforts in directions already entered upon, but also for their extension to other specified matters, to which they have not yet devoted adequate attention.

Dr. Thomson notes, furthermore, that one aspect of the sanitary administration of the district—that, namely, concerned with the internal management of the health department—is the reverse of satisfactory. There has been absent there that co-operation of Medical Officer of Health and Inspector of Nuisances, which is essential for proper exercise of the functions of both officials, and which is in effect enjoined by the Order of the Local Government Board. For instance, these officers have reported separately, and each with a different explanation, to the Sanitary Authority on the recent prevalence of enteric fever; and the Inspector of Nuisances' attitude in this matter has seemingly been tolerated by the Town Council. It is, of course, no part of the official duty of an Inspector of Nuisances to independently investigate problems which, as in this present instance, are essentially medical and scientific, and attempt of such officer to do this can only lead to friction, and thus to detriment of sanitary administration in various directions.

ENTERIC FEVER. COVENTRY.

A report by Dr. Darra Mair (Appendix A, No. 14) upon an outbreak of enteric fever at Coventry in the autumn of 1901 affords an instructive illustration of the complex considerations often involved in etiological research of this nature. The problem here was: An outburst of enteric fever in a circumscribed area comprising 86 houses, 29 of which were invaded by the disease; an outbreak, moreover, which appeared suddenly, rose rapidly, and as quickly subsided. *Prima facie* these facts were suggestive of causation of the fever by water or by food supply of some sort. But locally the fever prevalence was ascribed to a habit of certain of the inmates of the houses in question of playing in an unquestionably polluted river hard by; and particular facts, negative as well as positive, tended to support this view. Dr. Mair, however, furnishes evidence pointing to the conclusion that the main cause of the outburst of fever was specific pollution of a local well which, at the time that the cause of the fever outburst operated, formed the supply of

the bulk of the houses subsequently invaded. There is much to be said for this thesis, especially as regards inception of the outburst; and the fact that certain of the sufferers during the fever prevalence were believed not to have partaken of the implicated well water, even if based on entirely trustworthy testimony, does not suffice to negative or counterbalance the array of facts which Dr. Mair adduces. Similarly, the negative result which was obtained from chemical and bacteriological testings of the well water collected a week or two later than the date at which it was presumably disseminating infective matter is but in keeping with experience of other water-caused outbursts of enteric fever strictly limited in time. But however this may be, the facts set out by Dr. Mair respecting the incidence in time and in locality of the fever witnessed, obtain their particular interest from certain conditions to which the implicated well was exceptionally exposed at the very time that the sufferers by the outburst of fever in all probability received their infection. At the date in question there had been undertaken within the area which later on was invaded by fever certain water-closet alterations which not only were responsible indirectly for extra foulings of the yard in which the well is sunk, but also led to the opening of a trench within a few feet of the well itself for provision of a water main: So that heavy rainfall, amounting in two days to one and a half inches, which occurred about the same time, afforded an altogether exceptional opportunity for washing objectionable matters from the yard into the well.

Upon the whole Dr. Mair affords a very strong presumption indeed of the validity of his thesis as to water causation of the fever outburst at Coventry.

INSANITARY HOUSES, WHITEHAVEN.

An outbreak of enteric fever which occurred in Whitehaven during the autumn of 1901 led to request from the Town Council of the Borough for the services of one of the Board's Medical Inspectors. Dr. Bulstrode, who was instructed to make the necessary investigations, reported (Appendix A, No. 15) the outbreak in question as limited practically to two areas or groups of dwellings; the one known as Ginns, the other as Newhouses. No evidence was forthcoming implicating the public water supply, which is derived from Ennerdale Lake; nor was there suggestion that milk, shell-fish, or other article of food had been responsible for the outbreak. On the other hand the sanitary arrangements of the invaded areas were by no means satisfactory. Dwellings were crowded together; drains generally appear to have been markedly faulty; the water-closet accommodation was deficient, and in certain instances very defective; in particular cases the water-closet was placed in juxta-position with the kitchens of adjoining dwellings, and provided a means of access from one kitchen to the other. Enteric fever would seem, under the above conditions, to have spread chiefly by personal infection and largely by the agency of unrecognised and never notified cases.

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One of the most notable features brought out in Dr. Bulstrode's report is the state of overcrowding of dwellings upon area which still obtains in Whitehaven, a condition of affairs to which attention was drawn by the late Dr. Bristowe in his report to the Privy Council as far back as 1863. Dr. Bulstrode states that "wherever one turns, whether out of the small or the large thoroughfares, one finds deplorable courts and alleys where the direct rays of the sun are but rarely seen, and where even its diffused light is often difficult of attainment."

This unsatisfactory state of affairs, now so troublesome and costly to rectify, should serve as a warning to growing districts unprovided with adequate byelaws governing the erection of new buildings. In Dr. Bulstrode's opinion, "The demand for dwelling-houses which obtained at the time of Whitehaven's greater prosperity is apparently responsible for the present overcrowding of houses. It was then (there being at that time no proper building byelaws in force), that the gardens and back yards belonging to the houses then existing were handed over to the enterprising builder who soon converted every available patch of ground into a court or alley. The overcrowding which has resulted is unique in my experience."

DIPHTHERIA, HAVERFORDWEST R.D.

Dr. Wheaton's report as to the sanitary condition of the town of Fishguard, and of the village of Goodwick (Appendix A, No. 16) bears testimony to the eminently unsatisfactory state of affairs which still obtains in certain Rural Districts. The defective administration of the Haverfordwest Rural District Council has for some years been under the notice of the Board, and the appearance of diphtheria in Goodwick in 1901, was the occasion of their active intervention. Dr. Wheaton reports that, for the purpose of Public Health administration, Haverfordwest Rural District is divided into four sections, each with a separate Medical Officer of Health, and that there is a single Nuisance Inspector, who is in charge of the whole area. This system of divided expert control has been attended, as commonly happens in like circumstances, by absence of any approach to concerted administrative action in sanitary amelioration of the district. Neither isolation accommodation, nor disinfecting apparatus are provided in this district, while nuisances generally are permitted to go unabated.

In Fishguard, one of the diphtheria invaded areas, an accumulation of sewage was observed on the foreshore, many dwellings were without house-drains, and liquid filth appeared to be cast indifferently upon garden ground, into the streets, and into gulleys in connexion with highway drains. The pail privies of the place were commonly found neglected and filthy, and where these conveniences were wanting excrement littered the ground. At Goodwick conditions were equally unsatisfactory. In the Fishguard Schools "sore throat" had prevailed among the children for a year or more antecedent to the outbreak of

diphtheria. When the drains in relation with the school were examined after outbreak of definite diphtheria, these were found blocked, and the subsoil about the school much polluted by leakage from them. In his attempt to trace out the history of the diphtheria, Dr. Wheaton was altogether foiled, the notification certificates of the diphtheria cases having been destroyed, and no record of the facts respecting these cases had been kept. Action of the District Council in prevention of spread of the diphtheria appears to have been limited practically to closure for three weeks of the Fishguard School, and to exclusion of certain scholars from the Goodwick School. No disinfection of the clothing or of the dwellings of diphtheria patients had been practised. As a whole, the story of Fishguard and Goodwick, as told by Dr. Wheaton, is one of the least satisfactory that have in recent years come to the Board's notice.

TUBERCULOSIS.

Professor Koch's dictum, at the Congress on Tuberculosis held in London in July, 1901, as to the non-transmissibility of bovine tuberculosis to man, raised questions for the Board of no small administrative difficulty. At once it was assumed by the milk and meat trades respectively that the measures inculcated in this country in regard of milk of tuberculous cows and flesh of tuberculous food-animals were too stringent or even superfluous. On the other hand the weight of scientific authority was adverse to Dr. Koch's thesis, or was demanding that the validity of this thesis should be tested, so far as this might be done, by adequate experiment. In the circumstances, His Majesty's Government, on your advice, appointed a Royal Commission to inquire and report whether tuberculosis in animals and man is one and the same disease; whether animals and man can be reciprocally infected with it; under what conditions, if at all, the transmission of the disease from animals to man takes place; and what are the circumstances favourable or unfavourable to such transmission. Pending the investigations and report of this Commission, the Board was advised by your Medical Officer that there should be no relaxation, on the part of local authorities and their officers, of proper measures for dealing with milk from tuberculous cows and with tuberculous meat intended for the food of man. And accordingly the Board issued, 6th September, 1901, a circular letter in this sense to all Sanitary Authorities throughout England and Wales, calling at the same time attention to the principles, as laid down by the Royal Commission of 1893, which should guide authorities in these matters, and urging uniformity of action on the lines indicated.

Another administrative question arising out of the Congress on Tuberculosis with which the Board have been called upon to deal, has had to do with provision generally of Sanatoria for "consumptives," and especially with the ability of County Councils to come to the assistance of local authorities desirous of obtaining provision of this sort. On this latter point, one of large

administrative importance, the Board decided that:—In the event of a County Council constituting a hospital district under the Isolation Hopitals Act, 1893, to include all the urban and rural districts in the County, for the specific purpose of providing accommodation for consumptive patients, and of their making also an Order under section 26 of the Act (which would require the Board's approval) applying the expression "infectious disease" to consumption or phthisis strictly for the purpose of that Act, it would apparently be practicable for the Committee of such hospital district to enter into agreement, under section 3 of the Isolation Hospitals Act, 1901, with the governing body of a Sanatorium for "consumptives" for the reception into that sanatorium of consumptive persons from the County. In the above sense the Board advised the County Council of Westmorland in January, 1902, and has since advised other County Councils.

The Board, while continuing to advise, through their Medical Staff, other Departments of Government as regards Ordinances and Regulations for systematic repression of disease in Dependencies and Colonies in various quarters of the Empire, have been called upon from time to time, at the instance of the Foreign Office, to comment on important public health problems of Imperial and International concern. As regards not a few of the questions thus raised, far reaching issues have been involved; and further, the papers in respect of them have commonly been confidential documents. Accordingly, your Medical Officer, who has necessarily advised the Board and the Government in these matters, holds himself precluded from comment in this volume on the questions submitted, and on the considerations which have governed the advice he has rendered in connexion with them. I may add, however, that it has been the endeavour of your Medical Officer on these occasions to do all in his power to secure that administrative dealing with the questions at issue should be based upon broad and consistent views of public health policy.

The Royal Commission on Sewage Disposal has continued its labours, and your Medical Officer as a Member of the Commission has taken part in its proceedings. Your Medical Officer has also remained a member of the General Medical Council.

The volume of reports "On the Use and Influence of Hospitals for Infectious Diseases," which was published in 1882 as a supplement to the Tenth Annual Report of the Local Government Board and which was re-issued in 1894, has continued to be greatly in demand by local authorities. In the autumn of 1901 the copies on sale of this volume became once more exhausted, and further reprint of it was called for. The opportunity thus arising was utilised for incorporating with the volume, as re-issued, a preface drawing attention to the principal points respecting

construction, use, and management of hospitals for isolation of infectious diseases which in view of more extended experience deserve particular consideration by local authorities.

Dr. Parsons, one of your Assistant Medical Officers, was, during the year, nominated by the Board and served as the Board's representative on an Advisory Committee, appointed by the Board of Education, with reference to the work of the Geological Survey in accordance with a recommendation of the Inter-departmental Committee to which I referred in my report for last year.

Dr. Buchanan has during the year continued to serve as Secretary to the Royal Commission on Arsenical Poisoning.

Dr. Bulstrode has continued from time to time his re-inspection of Oyster-layings on the Coasts of England and Wales, and has inquired also as regards shell-fish generally on our foreshores, in reference to opportunities for contamination of edible molluscs by sewage.

Dr. Theodore Thomson has, in association with other Officers of the Board, held local inquiry respecting application of the Borough of Rotherham for a Provisional Order constituting Rotherham a County Borough, and similarly he has held inquiry respecting an application of the London Water Companies for new Water Regulations. As opportunity offered he has continued his investigation of complex problems concerning endemicity of enteric fever.

Inquiries have been held by Dr. Reece with reference to the constitution of Port Sanitary Authorities at Manchester and New Shoreham.

Dr. Manby commenced during the year inquiry as to the suitability of the Board's Model Series of Regulations for Dairies, Cowsheds, and Milkshops in the circumstances of a variety of districts, urban and rural.

Mr. Huddart has been engaged from time to time during the year in investigation of the conditions of employment and of remuneration of Inspectors of Nuisances, who, while not rendering whole time service in this capacity, are part paid out of County funds.

Summaries of notified attacks and certified deaths from certain infectious diseases in urban districts of England and Wales which in former years have appeared in the Report of your Medical Officer are not continued in this volume. Instead, the data have since the beginning of 1901 been published quarter by quarter in the returns of the Registrar-General; a course which was adopted in view of representations of the Incorporated

Society of Medical Officers of Health to the effect that advantage to Public Health administration was likely to accrue from issue of the information at shorter intervals than 12 months. The tabular statements as to sickness notification now issued quarterly by the Registrar-General are prepared in your Medical Officer's Department, and they include almost all the urban areas in regard of which the Registrar-General has been accustomed to publish quarterly statistics of mortality. That the statements are not complete as regards the Registrar-General's urban areas is in the main due to refusal of the authorities of certain health resorts to contribute information as to infectious sickness in their areas for publication in the way proposed to them. The attitude of these authorities is to be regretted. Their abstention in the matter is liable to be construed by intending visitors to the detriment of the districts concerned.

MEMORANDA AND CIRCULARS.

In Appendix A, No. 17, will be found reprinted memoranda and circulars relating to public health and vaccination, prepared or revised in the Medical Department during the year 1901. These were :—

A. MEMORANDA :—

(1.) Ship-borne rats and plague. (April, 1901.)

(2.) Memorandum on the steps specially requisite to be taken in places where small-pox is prevalent. (Provincial, March, 1901.)

(3.) Memorandum on the steps specially requisite to be taken in places where small-pox is prevalent. (London, September, 1901.)

(4.) Memorandum on the circumstances under which the closing of public elementary schools, or the exclusion therefrom of particular children, may be required in order to prevent the spread of disease. (September, 1901.)

B. CIRCULARS :—

(1.) Ship-borne rats and plague. (29th April, 1901.)

(2.) Tuberculosis. (6th September, 1901.)

(3.) Isolation Hospitals Act, 1901. (6th September, 1901.)

(4.) The Vaccination Acts, 1867 to 1898. (17th September, 1901.)

(5.) Small-pox in the Metropolis: Vaccination and Re-vaccination. To Boards of Guardians. (25th September, 1901.)

(6.) Small-pox in the Metropolis. To Metropolitan Borough Councils. (25th September, 1901.)

(7.) Small-pox. To Guardians in the Home Counties. (6th December, 1901.)

(8.) Small-pox hospital provision. To Councils of Boroughs or other Districts in Home Counties. (6th December, 1901.)

(9.) Notification of Chicken-pox and Re-vaccination of Sanitary Staff. To Metropolitan Borough Councils. (27th December, 1901.)

SMALL-POX.

The London small-pox epidemic of 1901-02, which was still in progress at the end of the period to which this report refers, must needs in due course be dealt with statistically by a variety of authorities central and local. In certain of its major aspects the epidemic as a whole will be thus dealt with by the Registrar-General and by the Medical Officer of the London County Council, in others by the Metropolitan Asylums Board; while in its minor and local aspects London small-pox has been or will be fully reported on by the several Medical Officers of Health of the Metropolitan Boroughs. For the present it will be enough to note broadly, chronologically and topographically, the behaviour of the epidemic for the purpose of reviewing the administrative action of the several bodies responsible in London for prevention or control of small-pox.

BEHAVIOUR OF SMALL-POX IN THE METROPOLIS.

In 1901 epidemic small-pox on the Continent of Europe, more particularly in Paris, was causing the Central Authority and Medical Officers of Health in London to be specially alert in the matter of introduction of this disease from abroad; an expectant attitude which resulted more than once in the course of the summer, in the immediate detection of imported small-pox and the speedy limitation of its spread. But in August there occurred in South St. Pancras and contiguous districts an outburst of small-pox the source of which could not with certainty be traced. In the fortnight ending 24th August, out of 29 small-pox attacks notified in the metropolis no less than 17 were referred to St. Pancras and other 3 to Holborn; while in the two next succeeding fortnights—those ending 7th and 21st September, of a total of 177 notified cases, 73 occurred in St. Pancras, 35 in St. Marylebone, and 13 in Holborn. By the latter date, 21st September, small-pox was being widely disseminated in London, as many as 20 out of the 29 Metropolitan Boroughs having become invaded. For a few weeks no alarming increase of the disease was witnessed. But early in November notifications, which in antecedent fortnights had numbered 83 and 76, rose at a bound to 227, and it became evident that a

serious epidemic of small-pox in the metropolis was not to be averted. Thereafter the disease steadily grew in amount until by the beginning of January, 1902, the fortnightly notifications had advanced to 546, a figure to which every metropolitan borough contributed. And not until April did small-pox in London as a whole show any tendency to decline, notifications fortnightly during February and March having numbered 726, 785, 816, and 847. The total notifications of small-pox in London from the beginning of the epidemic to the end of March amounted to above 6,000.

Severe and widespread as was the small-pox above indicated, it is not to be inferred that London in its entirety suffered heavily from the disease. Not a few metropolitan boroughs were throughout comparatively exempt from small-pox; and as regards certain of those suffering severely, epidemic prevalence of the disease did not involve any but limited sections of their areas. The boroughs which, wholly or in part, suffered most severely in the epidemic, and in regard of which therefore the administrative procedures within their areas of a number of different authorities having concern with small-pox became most important, were, in the later months of 1901, St. Pancras, St. Marylebone, Holborn, and Bermondsey; and in the early months of 1902, Shoreditch, Bethnal Green, Stepney, Poplar, St. Pancras, Hackney, Southwark, Camberwell, and Battersea.

ACTION OF THE BOARD.

The Board, alive to risk of introduction of small-pox from abroad, and mindful of the neglect of vaccination in the child population of London which has already been adverted to in this report, in the summer of 1901 lent encouragement to stringent dealings by Metropolitan Medical Officers of Health with imported small-pox, and sought through their Medical Department to bring about better administration of the vaccination laws on the part of London Boards of Guardians and their Officers. When it became evident that epidemic small-pox was fastening on London, the Board took prompt action in formally reminding, by Circular Letter dated 25th September, Vaccination and Sanitary Authorities throughout the Metropolis of their responsibilities as regards this disease. Copies of the Board's Memorandum "on the steps which should be taken in localities where small-pox is prevalent" in each instance accompanied the communication to the local authority.

The Circular to Boards of Guardians urged the prompt vaccination of all children or other persons not yet vaccinated and the promotion of re-vaccination amongst adolescents and adults. Attention was at the same time expressly called to the fact that in many Metropolitan Unions administration of the vaccination laws had been lax and inefficient, "and that in the Metropolis generally there are very many children who are unprotected by vaccination," and the Guardians were called on

"to see that their Vaccination Officers immediately take such steps as may be necessary to deal effectively with the arrears which may have accumulated . . . and to ensure that in all further cases of default the measures required by the Vaccination Order, 1898, are promptly taken." Further the Guardians were reminded of the desirability of house to house inquiries in invaded localities by Vaccination Officers for persons in need of vaccination, and of assistance being rendered to these Officers and to Public Vaccinators in carrying out their extra duties in the face of small-pox.

The Circular to the Metropolitan Borough Councils dwelt on the importance of "the most energetic measures being taken . . . with a view to preventing the spread of infection," and urged that the Medical Officer of Health should "in every case which may be notified to him, or which may come to his knowledge, immediately visit the house where the disease has broken out, and at the earliest possible moment take such measures as may be necessary to secure as far as practicable the isolation of the patient, the vaccination of any persons who may have been exposed to infection, and the disinfection of the premises, and any further action which the circumstances will admit of for the purpose of checking the extension of the disease." The Board suggested also that the Sanitary Authority "should, as regards each case be informed precisely of the measures which have been taken by the Medical Officer of Health," and desired that copies should be sent to them of the reports made by that officer in each instance.

On 14th September, 1901, the Board addressed a letter to the London School Board drawing attention to the large number of unvaccinated children in certain parishes invaded by small-pox and noting the desirability of securing the prompt vaccination of these children in order to diminish risk of their conveying infection from small-pox invaded houses to children with whom they might come in contact at their Schools. Belief was being entertained, the Board pointed out, that the School Board were unwilling that their Schools should be visited by Public Vaccinators for the purpose of examining children's arms as to vaccination; and the Board therefore urged the School Board to render such assistance as was within their power in enabling Vaccination Authorities to ascertain, by actual inspection of children's arms in the Schools under control of the School Board, which were the school children that were not protected by vaccination.

In reply the School Board sent copy of a Resolution adopted by them 23rd September, as follows:—

> "That facilities be given to the public Vaccination Officers of the Metropolis, on the application of the proper authority, to enter the schools of the Board, in infected

areas, for the purpose of examining the arms of the children, with a view to advising the parents to allow their children to be vaccinated, provided that the School Board issue a Circular to the parents asking if they have any objection to their examination, and in case of such objection in any particular case, that such examination shall not take place; and that the Local Government Board and the public Vaccination Officers be informed accordingly."

Later, 27th December, 1901, on its becoming apparent that cases of small-pox were not infrequently escaping detection owing to their being regarded merely as cases of chicken-pox, the Board addressed a further Circular to the Borough Councils suggesting the desirability of the Council at once taking steps to add chicken-pox, either temporarily or permanently, to the list of diseases required to be notified in the borough under the provisions of section 55 of the Public Health (London) Act, 1891. In the same Circular the Board adverted, in view of recent instances of members of the sanitary staff of Metropolitan boroughs, especially persons employed in the disinfection of infected dwellings and infected articles, having contracted small-pox, to the need for "any officer employed by the Council who is to come in close relation with persons or articles infected with small-pox, being first protected by efficient re-vaccination."

Finally, early in 1902, the Board addressed a Circular to the Borough Councils on the subject of so-called small-pox "contacts," question having arisen as to the action which local authorities should take in order to deal effectively with the inmates of invaded dwellings. This Circular pointed out that under ordinary circumstances the quarantining at their homes of inmates of such dwellings is not necessary in districts in which sanitary matters are properly administered and vaccination and re-vaccination are efficiently carried out. At the same time the Board recognised the probability that occasions would arise in which additional precautions would appear called for, as, for example, when laundries were in question, or where the habits of the inmates of an invaded house were such as to make it difficult for proper supervision of them to be maintained. In such exceptional cases, it was intimated, the Board would be prepared, provided the Medical Officer of Health had advised that in the special circumstances it was essential that the inmates should remain in their own houses, to sanction a reasonable expenditure in securing such result.

As time went on and the epidemic progressed, the Board, not content with tendering advice to the authorities in the Metropolis having to deal with small-pox and with vaccination and to their officers, directed that investigation should be made by the Inspectors of their Medical Department of the action taken by

each of the Vaccination and of the Sanitary Authorities concerned. Accordingly every Town Clerk and every Medical Officer of Health, every Clerk to the Guardians, and every Vaccination Officer in the Metropolis was visited; the Inspector tendering advice where necessary, and encouraging co-operation between the various officials concerned. So far as appeared necessary too, a like course was adopted in regard of Public Vaccinators and other and subordinate officers. And throughout the advice and assistance of the Board's Officers, Medical and other, at Whitehall, was at the disposal of Metropolitan Officers desiring conference as to matters of difficulty arising in exercise of their functions.

Action of the Metropolitan Asylums Board.

The procedures of the Metropolitan Asylums Board as hospital authority and as ambulance authority for London have been already dealt with in the report of the Board. Here it is not necessary to say more than that under circumstances of exceptional difficulty and pressure the authority in question expanded and increased both its hospital accommodation and its land and river ambulance service so as to keep pace always with the demands of the Metropolis. Throughout the epidemic no disadvantage to London arose by delay of removal of small-pox patients from their homes or of their reception and treatment in hospital. There can indeed be no doubt at all that the efficiency of the Metropolitan Asylums Board as hospital and as ambulance authority largely contributed to such measure of success as was attained in dealing with London small-pox. It may be, and probably it is, true that in effecting this supreme service for London, other districts outside the Metropolis were, through the operations of Metropolitan Asylums Board, placed at a disadvantage in the matter of small-pox, and suffered unduly in consequence from that disease. In part, no doubt, the disadvantage those districts suffered in this respect was one which is inseparable from presence in their neighbourhood of small-pox establishments such as those of the Metropolitan Asylums Board; largely it was also due to the special circumstances which brought about employment of a large staff of insufficiently protected workpeople in the immediate neighbourhood of ships and wards filled with acute small-pox.

Action of the London County Council.

The London County Council has not direct concern with details of public health administration in the Metropolis in connexion with infectious disease. But through its Medical Officer of Health, the Council was able in several ways to come to the assistance of the authorities directly responsible for administration. As regards common lodging houses and Salvation Army shelters, for instance, over which the Council has jurisdiction, measures were taken, at an early stage of the epidemic, for keeping these establishments under specially strict supervision of the County Council's officers, and in the event of small-pox occurring in a common lodging house daily inspection of the inmates was

undertaken with a view to calling in one of the Council's Medical Officers of Health should further sickness show itself. Meanwhile, the inmates of such invaded lodging house were encouraged, by offer of free bed and of small sums for food, to continue to reside in the same house under observation until the period in which small-pox would have become manifest in them had they been infected had passed. In particular instances the County Council rented all the beds in an invaded common lodging house, making an allowance for food to all inmates who consented to remain for a while in the house under supervision, and using the house also as a "shelter" for small-pox contacts from other common lodging houses who had been especially exposed to small-pox. Later, at the beginning of 1902, and in view of unsuspected sources of small-pox, the County Council issued an Order, which was confirmed by the Board, requiring the notification of chicken-pox throughout London, and made arrangements by which the services of medical men familiar with small-pox were to be available for the purposes of diagnosis. About the same time the County Council arranged, at the request of the Metropolitan Branch of the Society of Medical Officers of Health, a system for communicating daily to all London Medical Officers of Health certain particulars respecting such newly-invaded dwellings as were reported day by day to the Council. In this way valuable information as to small-pox contacts was made on very short notice available for every Medical Officer of Health in the Metropolis, and the control and supervision of such persons in districts other than those in which they had been definitely exposed to small-pox were to a corresponding extent secured.

ACTION OF BOROUGH COUNCILS AND BOARDS OF GUARDIANS.

On local inquiry by the Board's Medical Staff while the epidemic was still progressing, it was found that the action taken in response to the Board's circulars and memoranda by the local authorities charged with executive duties in relation to small-pox had been various and not always satisfactory. Speaking generally, the administration of the Borough Councils—more particularly the work of the Borough officials—had been to a large extent uniform, and for the most part efficient. Cases of small-pox had been promptly handed over to the Metropolitan Asylums Board for removal to hospital; invaded houses had been disinfected; and infected articles, as also articles suspected to be infected, had been removed to the Borough disinfectors. Certain Borough Councils, however, had not, it appeared, provided beforehand (as required by section 60 (4) of the Public Health (London) Act, 1891) "shelters" for the accommodation of families while their invaded homes were undergoing disinfection, and observation of "contacts," as well as transmission of information respecting "contacts" belonging to other districts, had not been fully maintained in every borough. Now and again too, in particular districts where small-pox had been rapidly extending, a tendency had appeared toward hurried performance of, or delay in, disinfection, indicating that the

need for increase of disinfecting staff in face of an epidemic had not been sufficiently recognised. Nevertheless, so far as administration of small-pox is parallel with administration of ordinary infectious disease, little fault was to be found with the bulk of the Metropolitan Boroughs; and most of them proved prompt, on representation by the Board's Officers, to rectify defects in their methods. But where sanitary administration had come in touch with vaccination, and therefore with Boards of Guardians (more particularly where the Guardians were inactive or hostile to Vaccination), the preventive measures adopted by the Borough Councils were, in several instances, less thorough than they should have been. Thus, certain Borough Councils had omitted to seek authority from the London School Board for such examination, by officers of the Guardians, of the arms of children in the elementary schools, as it was open to them to make. Others again, reflecting perhaps the antagonistic spirit of the Guardians, had seemingly discouraged their Medical Officer of Health taking any action other than the every day "sanitary" procedures to which they were accustomed. Some Borough Councils, indeed, had in the matter of vaccination, proved so far recalcitrant as deliberately to have abstained from making it a condition of their service that their Sanitary Inspectors and disinfecting officers should be efficiently re-vaccinated. Thus, one such council which repeatedly rejected the direct advice of the Board in this matter, in the end paid penalty by loss, temporary or permanent, of the services of no less than five of their officials through attack by small-pox.

Indifference or contrariness of the above sort, though unusual among Borough Councils, was unhappily by no means exceptional in the case of Boards of Guardians having responsibility as to vaccination in areas of London seriously affected by the epidemic; and the effect of such attitude on the part of Guardians was necessarily in the direction of hindering and even paralysing Borough authorities desirous of dealing promptly and efficiently with small-pox. Vaccination authorities, for instance, which in the past had so mismanaged matters that one-third to one-half the children in boroughs within which they had vaccination responsibility remained, at the date of the epidemic, altogether unprotected against small-pox, were too often found to have made little if any effort at repairing their past errors and omissions. Particular Boards of Guardians had declined to instruct their public vaccinators to examine the arms of school children, or they had neglected to inform the public, by handbills and placards, when, where, and by whose assistance persons who had escaped primary vaccination or who had deferred their re-vaccination might obtain gratuitously the protection they should be desiring; or they had deferred or neglected to open vaccination stations, or to appoint assistants to their vaccination officers for the purpose of house-to-house advocacy of vaccination and dissemination of verbal and other information as to times

and places where vaccination was to be gratuitously obtained. Neglect in this latter particular was the more serious for the reason that, vaccination stations having disappeared under the Act of 1898, London people did not know (unless they were parents of very young children) how, when, and where gratuitous vaccination and re-vaccination were to be procured. Very possibly, in particular instances, the indifferent or even hostile attitude exhibited by certain Boards of Guardians towards vaccination would have proved disastrous but for the circumstance that their officers possessed commonly a keener sense of duty than their paymasters, and for a pronounced and growing tendency on the part of Borough Councils to supersede defaulting Boards of Guardians in exercise of those functions of the Poor Law Authority which pertain to vaccination. It is not surprising that Borough Councils which are, whereas Guardians are not, responsible for the public health of the population, should have been disposed to act thus in the circumstances.

It has not been necessary, or indeed expedient, to differentiate in this report degrees of excellence among those Metropolitan Boroughs wherein sanitary administration in the face of epidemic small-pox was on the whole of a high order, nor on the other hand to specify from among a plurality of Boards of Guardians those whose work in the small-pox emergency was specially and unenviably conspicuous for default of vaccination administration. One vaccination authority however among those whose action was found commendable, may be mentioned as having acted with great efficiency on the lines of the Local Government Board's Orders, Circulars, and Memoranda. This was the Board of Guardians for St. Giles and St. George, Bloomsbury. Under this vaccination authority very thorough measures were adopted in control of small-pox at an early stage of the epidemic, as follows :—

(*a*) The Guardians arrangements, ordinary and special, for vaccination and re-vaccination were very well advertised.

(*b*) The advantages of vaccination were brought prominently and repeatedly before the public.

(*c*) House-to-house visitation was practised throughout the Union, with a view to advising re-vaccination and to arranging for its performance on individuals desiring it.

(*d*) The Vaccination Officer maintained careful supervision of his birth lists, insisted on the vaccination of each infant as it became due, and prosecuted defaulters.

(*e*) The arms of children in the Elementary Schools were duly and systematically examined; the vaccination officer followed up all such children as were discovered to be unvaccinated; and took the necessary steps to secure their vaccination.

Holborn is the Borough which has profited by action in the above sense of this efficient Board of Guardians. The Borough was early invaded by small-pox, and, despite the co-operation of vaccination and sanitary authorities equally active and competent, for a time suffered very heavily by the epidemic. The fact that it did so suffer detracts nothing from the credit due to the authorities jointly concerned in repression of the small-pox. There can be little doubt that but for the energy of these Guardians and of the Borough Council that portion of Holborn Borough comprised in the Union of St. Giles and St. George would have suffered more severely than was actually the case; or that but for the excellent system of co-operation against small-pox here adopted by independent authorities jointly responsible for repression of the disease the rapidly growing and severe epidemic in Holborn would have been far less readily brought under control.

Epidemicity of small-pox in the Metropolis in the autumn of 1901 of necessity involved risk of extension of the disease to extra-metropolitan districts in many ways closely associated with London. Accordingly the Board proceeded, by circular letter, early in December, to remind Vaccination and Sanitary Authorities in the Home Counties of the risks to which their districts were being exposed through London small-pox, and of the duties incumbent on them in consequence. Both classes of authority received at the same time from the Board the Office Memorandum as to steps specially requisite in places where small-pox is prevalent; and, in particular, Sanitary Authorities outside London were reminded that in the matter of hospital accommodation for small-pox they would have to rely not as in London on the Metropolitan Asylums Board but upon arrangements made by themselves, alone or in conjunction with other Councils, and all were urged to lose no time in making such hospital provision if they had not already done so.

Very soon in Kent and in Essex outbreaks of small-pox directly or indirectly related to the London epidemic called for more active intervention by the Board. Allegation having been made that the hospital ships in Long Reach, and other small-pox establishments of the Metropolitan Asylums Board in that neighbourhood, were disseminating small-pox on both sides of the Thames, a Medical Inspector was forthwith directed to visit the Registration Districts of Orsett and Dartford for the purpose of conferring with and advising the several authorities concerned, in matters of vaccination and small-pox administration. And as time went on, other districts and Unions around London having meanwhile become affected or seriously threatened by small-pox, Medical Inspectors were deputed to visit a large number of local authorities for the purpopose of advising them and their officers on the lines already adopted in regard of the Metropolis. In

this way, late in 1901 and early in 1902, twenty-one extra-metropolitan Unions and no less than seventy-seven sanitary districts came administratively under the special supervision of the Board.

PLAGUE.

In a special Plague Volume* which has been issued by the Board while this report is passing through the press, Dr. Bruce Low gives, in continuation of the history of plague throughout the world which has been compiled from time to time by your Medical Department, account in detail of the behaviour of this disease in various countries during the three years ending 30th June, 1901. In an "introduction" to that volume I have considered plague in a variety of aspects, topographical, etiological, clinical, and other, and have indicated broadly the administrative attitude that, in the present condition of incertitude respecting the malady may, in my view, reasonably be held towards plague by this and other countries. Accordingly, in commenting on Dr. Brüce Low's further account of the progress and diffusion of plague to the end of 1901 (Appendix A, No. 18) I limit myself in the main to summarising the facts which he reports.

India suffered in 1901 more heavily from plague than in any one of the five preceding years. As compared with 1900, India's plague deaths were trebled. Partly this increase of plague was due to extension of the disease to Provinces and States hitherto free from it, but mainly it was due to increased prevalence of plague in areas in which it had already become endemic—as, for instance, Bombay. China, like India, continued in 1901 to suffer heavily from plague. At Hong Kong, plague deaths in this year were more numerous than in any year since 1894. In the island of Formosa, too, the mortality from plague was quadruple that of 1900. But elsewhere in the Far East outbreaks of plague were comparatively few or were insignificant; in Japan, for instance, in 1901 only seven cases of the disease were recognised.

Similar paucity of plague is reported in 1901 from Australia, the Straits Settlements, New Caledonia, Sandwich Islands, California, Brazil, the Argentine, Arabia, Mesopotamia, and Persia, many of which countries, or parts of them, had suffered plague in greater or less degree in the preceding year. In Africa plague re-appeared in .901 in the Cape Peninsula, at Port Elizabeth, and at Mossel Bay; but in none of these places did the disease become seriously epidemic. The total deaths from plague during the year in South Africa amounted to no more than 420.

* Reports and Papers on Bubonic Plague: by Dr. R. Bruce Low, 1902 [Cd. 748].

Coming nearer home, Egypt, situated on the highway between East and West, suffered in 1901 very little from plague, though the disease made its appearance in nine separate localities of the country. The total plague cases reported from Egypt in 1901 numbered 206, and the deaths 104. In Asia Minor a few plague cases were reported in 1901, from Samsoun and from Smyrna, but in no part of that country did the disease become at all prevalent.

As regards Europe, plague appeared early in 1901 at Constantinople; but no epidemic followed, the total plague cases in the year amounting only to 28. At Odessa also there were a few cases. Other places in Russia, in 1901, reported to be similarly affected in minor degree by plague, were Batoum, Kutais, and a village called Kotowo, in the Government of Saratoff. In Italy, Naples was affected in the autumn of 1901 to the extent of about two dozen plague cases. Besides Turkey, Russia, and Italy, no plague is known to have occurred in 1901 among the populations of any European Countries except Great Britain, where Glasgow and Liverpool were affected by the disease, in each instance in a very trifling degree.

Of plague in Glasgow Dr. Bruce Low is able to give, on Scottish authority, an interesting account. Two limited outbreaks occurred there; one in August, the other in October. The August outbreak, which comprised five cases, appeared in a locality in which plague had shown itself in 1900; that which occurred in October, comprising also five cases, was in a different quarter, and in connexion with one of the city hotels. In neither instance was the source of infection definitely traced, though rats were locally suspected of having fostered the disease. As to this, however, Dr. Low points out that in regard of only one group of attacks was there coincident plague among rats; as regards the other, rats in the neighbourhood of the invaded dwellings would seem to have been practically free from illness of the nature of plague.

In Appendix A, No. 19, Dr. Bruce Low gives account of plague and suspected plague in districts, port and other, which are directly under the Board's jurisdiction. As regards plague ashore, Dr. Low notes 13 instances in which, suspicion as to the presence of this disease having arisen, the aid of the Board was sought by the local authority in confirmation or disproof of the provisional diagnosis. In two only of the thirteen was the illness in question found to be plague, namely at Cardiff in February and at Liverpool in October. At Cardiff plague in the human subject was limited to at most two cases, but antecedently, concurrently, and subsequently, rats suffered somewhat severely from plague and over a considerable area of the dock region. At Liverpool the plague outbreak comprised eleven cases, as to the source of which nothing could with certainty be discovered. No evidence was forthcoming at Liverpool as to

plague among rats, though careful search for such evidence was conducted in the invaded dwellings and, indeed, throughout the city. Many rats were in the process of this search submitted at the Thomson Yates Laboratory to bacterioscopic test, but in no instance with a positive result as regards plague. Full reports on these plague outbreaks have been supplied by Dr. Low; on that at Cardiff in the plague volume already referred to, on that at Liverpool in the Appendix to this report now in question. At both places, it deserves notice, the administrative measures undertaken by the local authorities and their officers in combating the plague left nothing whatever to be desired.

Shipborne plague, actual or suspected, at ports of England and Wales in 1901, was reported in thirty-three instances. But in two instances only did vessels in question bring plague cases to our shores; in a third instance plague on board the implicated vessel was, and remained, limited to rats. Account of all three vessels has already been given by Dr. Low in the Board's Plague Volume. As regards the remaining 30 vessels which are in question, six of the ships had become plague-free before arrival in port, and 27 others were found, on bacteriological examination of material from patients on board them, not to be harbouring illness of the nature of plague.

Notwithstanding the alertness as regards plague and the administrative capacity in dealing with it on the part of local authorities of which evidence has been thus incidentally adduced, the Board did not relax their vigilance or their supervision in matters relating to this disease. In April, 1901, the Board issued a Circular to local authorities with reference to shipborne rats, urging that steps should be taken at sea-ports with a view to preventing the introduction of plague by means of rats shipborne from infected ports abroad, and enclosing a Memorandum on this subject by your Medical Officer. Further, for the purpose of ascertaining the preparedness of Authorities to deal successfully with imported plague, as well as for conferring with officials as to precautionary measures, the Board directed a number of sea-ports to be revisited by the Inspectors of the Medical Department. And similarly, on the occurrence of certain cases of locally suspected plague in districts within the outer ring of London, the Board, mindful of the provisionally adequate arrangements which had been already made within the Metropolis, deemed it proper that certain extra-metropolitan sanitary authorities should be reminded of their responsibilities in the matter of plague, and at the same time advised as to precautionary measures desirable to be taken beforehand in readiness for dealing with actual or suspected cases of this disease. Accordingly Drs. Sweeting and Mair, who were selected for this duty, visited in the summer of 1901 a number of districts; among them the Boroughs of West Ham and Croydon, the Urban Districts of Acton, Ealing, Chiswick,

Brentford, Willesden, Hendon, Hornsey, Tottenham, Bromley, Chislehurst, Beckenham, and Wimbledon, and the Rural District of Croydon.

CHOLERA.

Cholera since 1896 has been absent from Europe and the near East, and during several years therefore the annual summary as to the behaviour of the disease has been omitted from your Medical Officer's Report. Meanwhile, however, the disease has maintained its hold on India, particularly on Bengal, and in 1900 underwent large increase in many Indian provinces. In 1901 cholera exhibited a tendency to epidemicity outside India, beginning also to trend as in former days westward, and in the early months of 1902 broke out in the Hedjaz, where it raged among the pilgrims, causing an uncertain but large number of deaths. Later in 1902, after dispersal of the Mecca pilgrimage, the disease broke out in Egypt causing many thousand deaths, and also invaded Palestine. This behaviour of cholera may be thought of as threatening extension of the disease to Europe in the not distant future, and accordingly, Dr. Bruce Low has resumed record of cholera prevalences in continuation of previous series. In Appendix A, No. 20, he summarises manifestations of cholera throughout the world in the six years 1896–1901.

AUXILIARY SCIENTIFIC INVESTIGATIONS.

PLAGUE PROPHYLACTIC.

As a preliminary to investigation of the nature and effects on the animal body of the active principles contained in Haffkine's Plague Prophylactic, Dr. Klein has sought (Appendix B, No. 1) to ascertain how far the blood of an animal "prepared" against plague yields evidence of the protection afforded. To this end he tested the results on the blood of certain rodents of injection into these animals of plague bacilli living and dead, and of injection, into parallel series, of Haffkine's prophylactic—in its entirety and separately as to its solid and liquid elements.

Guinea-pigs, it is well known, are only with difficulty made resistant to plague, whereas rats are by comparison "immunised" readily; and accordingly it was anticipated that both as regards substances germicidal to plague bacilli and plague agglutinins, a broad distinction might be found between the blood of the inoculated guinea-pig and the blood of the inoculated rat, which might serve as a useful basis for further investigations. The outcome, however, of a large series of experiments by Dr. Klein in this connection proved altogether disappointing.

In the blood of none of the experimental animals—neither in that of guinea-pigs nor in that of rats—was any germicidal substance discoverable as a result of Dr. Klein's inoculations.

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On the other hand, plague agglutinins developed readily enough in the blood of guinea-pigs which failed to obtain protection, but were much less readily produced in the blood of rats, though these animals had become satisfactorily protected against plague by the inoculations of Haffkine's fluid to which they had been subjected. Dr. Klein concludes his report in detail on the above investigations by recording some interesting clinical observations on the results of plague inoculation of rodents.

CHEMICAL PATHOLOGY OF INFECTIOUS DISEASE.

Dr. Martin in resuming study of the Chemical Pathology of Infectious Disease has commenced investigation of the chemical products of diarrhœa-producing bacteria, and in Appendix B, No. 2, he gives account in the above sense of Bacillus Dysenteriæ. Using samples of this micro-organism of approved high toxicity to guinea-pigs, he finds in a series of experiments on rabbits that a soluble poisonous body is formed on culture of the bacillus in certain liquid media; that the filtrate of such culture, on intravenous injection into the rabbit, operates, at once to lower the body-temperature of that animal, causing at the same time notable diarrhœa, and tending to induce loss of body weight. Further, he finds that this poisonous quality of the products in culture of the bacillus is not due to presence in the cultures of any non-proteid body, and that a very potent poison indeed, similar in kind to that possessed by filtrate from a culture, is present in and is bound up with the intra-cellular substance of the bacillus itself.

ANAËROBIC BACTERIA.

Much confusion has arisen between certain kinds of anaërobic bacteria which are present constantly in sewage, and which are also apt to occur, though less abundantly, in water and in foodstuffs. Of these, bacillus enteritidis sporogenes is the most important on account of its potential pathogenicity for the human subject, and differentiation therefore of this microbe from other anaërobes with which it has been confounded is especially desirable. In search of a standard test for bacillus enteritidis sporogenes, Dr. Klein has made comparative study, under a great variety of conditions, of this micro-organism and of bacillus butyricus and bacillus cadaveris sporogenes, the anaërobes most frequently confused with it; and as a result he supplies (Appendix B, No. 3) data likely to be of much service to fellow workers, not only in differentiating the three anaërobes in question, but also, and particularly, in providing means of ready identification of that member of the group which is apt to prove pathogenic.

IDENTIFICATION OF B. DIPHTHERIÆ.

Dr. Gordon's investigations (Appendix B, No. 4) regarding a series of micro-organisms bearing resemblance to the (Klebs-Loeffler) bacillus diphtheriæ deserve attention, not only of bacteriologists whose daily duty it is to pronounce upon specimens obtained from the throats or noses of persons suspected to be suffering from diphtheria, but also of medical practitioners and medical officers of health, who in such cases are often relying

upon the dictum of the bacteriologist to determine the action which should be taken in the interests of the patient and of the public.

Nearly always it is essential that the opinion of the bacteriologist should be obtained with speed, for example, within 24 hours, or thereabouts. This necessity precludes a report based upon inoculation of guinea-pigs, and thus excludes an important means of differentiating B. diphtheriæ from other microbes which may be derived from the human throat and nose, some of them closely akin to B. diphtheriæ, and others, such as Hoffman's bacillus and B. coryzæ segmentosus, belonging to species which in certain of their characteristics bear a strong resemblance to B. diphtheriæ. But a series of morphological and cultural tests which Dr. Gordon describes have in his hands proved sufficient, when carefully applied, to eliminate the majority of micro-organisms thus resembling the diphtheria bacillus (including those which most commonly give rise to difficulty) and to enable a statement to be made with much confidence at the end of 18 hours that true B. diphtheriæ is present. Investigation of the agglutinating properties of blood of guinea-pigs inoculated with B. diphtheriæ and allied forms has led him to conclude that, on occasion, agglutination tests may also afford useful confirmatory evidence of the presence of the diphtheria bacillus.

On the other hand, none of the tests described by Dr. Gordon, morphological, cultural, or agglutinative, can be said to enable the absence of B. diphtheriæ to be asserted, within 24 hours or thereabouts, with a like degree of confidence. It is still essential, in our present knowledge, to avoid attaching undue importance to a single reported failure to discover B. diphtheriæ, and in such a case to obtain bacteriological examination of further specimens.

AGGLUTINATION.

Identification of enteric (typhoid) fever, especially in its earlier stages, is another matter which is administratively of no small importance. To this end reliance is being, in practice, increasingly placed on the "Widal" reaction; on the ability, that is, of serum of the blood of the suspected fever case, when added in minimal amount to a broth culture or emulsion of the typhoid bacillus, to cause precipitation (or "clumping") of the bacillary bodies suspended in such broth or emulsion. But there has arisen diversity of opinion as regards the degree of dilution of fever serum with broth or with emulsion, at which a positive result of the above test is trustworthy; and further, it has been maintained that the ability of the serum of typhoid fever cases to precipitate bacteria is not limited to the typhoid bacillus, but extends on occasion to Bacillus coli and coli-like microbes. Accordingly Dr. Klein has (Appendix B, No. 5) re-investigated this subject, and he finds that though now and again typhoid blood-serum, whether of man or of prepared

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rodents, is capable of causing agglutination of bacilli other than typhoid bacilli, it rarely happens in his experience that any blood-serum of the human subject, other than that yielded by typhoid fever cases, will, except in very "low dilutions," agglutinate the typhoid bacillus. Further, he finds that "typhoid blood-serum," human or other, fails generally in his hands (except in very "low dilution") to agglutinate coli-like microbes, and fails always as regards B. coli which has been isolated from the bowel discharges of enteric fever. Apart, however, from the human subject, Dr. Klein's experience is not to the same effect. The blood-serum of typhoid immunised guinea-pigs is, he finds, now and again capable of agglutinating, not only the typhoid bacillus, but also bacilli of the coli group. Furthermore, he finds that the serum of guinea-pigs "prepared" by injection of microbes such as Gärtner's bacillus and Danysz's bacillus is capable, even in high dilution, of agglutinating not only "the bacillus of injection," but also the typhoid bacillus.

INOCULATION OF SOIL WITH SEWAGE.

In further observation of the fate of sewage microbes when brought in competition in the open country with the bacteria proper to surface soils, as happens when sewage is subjected to "land treatment," Dr. Houston has obtained (Appendix B, No. 6) results altogether corroborative of his previous researches. The addition of sewage, whether to garden (manured) mould or to virgin soil, does not in either case lead to definite increase in the superficial layers of the soil of the micro-organisms proper to sewage. On the contrary, in soils of both sorts microbes typical of sewage tend to die out; more speedily in garden mould where the sewage microbes come in competition with abundance of hardy soil bacteria, less quickly in virgin soil where competition in this sense is less keen. As regards those sewage microbes which are reputedly of direct intestinal derivation and which may be thought of therefore as potentially pathogenic, the same general indications are forthcoming. Streptococci, for instance, of definitely recognisable characters exhibited a very short retention of life on the experimentally irrigated areas; and B. coli of completely typical sort quickly disappeared from the sewage treated plots, though microbes seemingly akin to B. coli were more persistent and even (on occasion and in a limited sense) exhibited recrudescence. How far, however, persistence of B. coli "atypical" in its reactions was due to greater vitality under surface soil conditions of microbes which when introduced into the soil already possessed the characteristics of this group of sewage micro-organisms, or is to be referred to loss by typical B. coli in these circumstances of its positive attributes, are questions which may not yet be answered. But if reply hereafter should be that the chief cause of disappearance of typical B. coli from the superficial soil is the result of modification of this microbe under the conditions of its new environment, students of analogy who are epidemiologists will be led to seek elsewhere than in the superficial soil for telluric conditions such as are suspected by

them on occasion to favour sudden and large multiplication of bacillus typhosus outside the animal body, and are associated with dissemination of the essential cause of enteric fever wholesale along with water supplies.

In the above connexion, remotely in reference to the typhoid bacillus but more immediately as regards bacillus coli, Dr. Houston's further investigation (Appendix B, No. 7) of wells at Chichester is particularly interesting. These wells, it will be remembered, are sunk through a foul surface soil into coarse gravel overlying clay of the London and Reading beds, and are so constructed as to permit lateral flow of subsoil water through them. Twenty additional wells at Chichester have come under Dr. Houston's observation, ten of them in "fever," ten in "non-fever" areas As before, he found the water yielded by Chichester wells generally unexceptionable from a chemical point of view; only in regard of a few of them did the amount or the variation of chlorine afford ground for some suspicion. But from a bacteriological standpoint it was otherwise. From no less than nine of the twenty wells Dr. Houston obtained at one time or another typical bacillus coli, and though many of the wells yielded water exhibiting in the aggregate but few bacteria per cubic centimetre, a considerable number of these waters furnished bacillus coli or coli-like bacteria in proportions, relative to total micro-organisms, far in excess of that usually held permissible in potable well water. It is true that Dr. Houston did not in any well water detect bacillus typhosus. Nevertheless, the circumstance that he obtained from his samples no less than 81 coli-like bacteria in regard of which he judged it necessary to assure himself by a series of detailed experiments that they were none of them bacillus typhosus is at once testimony to the painstaking care he gave to his investigation and to the suspicion that he was entertaining bacteriologically as to the uniform safety of certain of these well waters. Besides the above 81 micro-organisms of the coli-group which were in a sense suggestive of B. typhosus, Dr. Houston studied, sufficiently to satisfy himself that none of them was identifiable with that microbe, no less than 225 other bacteria which on preliminary observation could not definitely be differentiated from the enteric fever micro-organism. As he anticipated, the majority of these proved to be B. coli or allied forms. Of typical B. coli isolated by him from the well waters, a small proportion were, as in the previous year, agglutinated by the serum of a "typhoid-immunised" guinea-pig. No one studying this series of Dr. Houston's reports will, I think, fail to agree with his suggestion as to the advisability of closing all drinking-water wells in Chichester.

It deserves notice that Dr. Houston in this further report on water-testing once more lays stress on the importance, in judging water bacteriologically, of considering *both* the numbers

MEDICAL OFFICER'S REVIEW.

and the biological characters of B. coli detectable in the samples. Neither the one nor the other basis of inference is in his view by itself satisfactory. At the same time, Dr. Houston is careful to place on record in much detail all his facts; so that these may be judged of apart altogether from his inferences. It would seem essential, in our present knowledge, to hesitate before accepting, in reference to the presence of B. coli in a given material, mere statements which are unaccompanied by details of the characters of the microbes that have been "identified" as this bacterium; and this is evidently Dr. Houston's view.

HÆMORRHAGIC SMALL-POX.

Difficulty having arisen in the course of the London small-pox epidemic as regards diagnosis of hæmorrhagic small-pox, Dr. Klein was instructed to study by bacterioscopic methods such cases of this malady and of "purpura hæmorrhagica" (which it was suspected was being confounded with small-pox) as might for this purpose be brought to his notice. In Appendix B, No. 8, Dr. Klein gives account of a case of acute fatal purpura and of a series of cases of hæmorrhagic small-pox with which he was enabled to contrast it. As regards the particular purpura case, he found present in the blood after death virulent diplococcus pneumoniæ in enormous number; a condition fully sufficient, in his view, to account for death of the patient by acute severe illness with hæmorrhages cutaneous and other. On the other hand, he failed altogether to find in the blood of persons dead of hæmorrhagic small-pox any evidence of general blood infection; no more in fact than, and in kind not different from, what is found by present bacterioscopic methods in every day small-pox. He infers therefore that whatever may be the cause of the hæmorrhagic condition of particular cases of small-pox, septic bacteria are not, as was diplococcus pneumoniæ in the purpura case in question, in any way directly concerned with the result. But, however this may be, Dr. Klein discovered yet another, a non-bacterial, and as he believes a fundamental, means of distinguishing purpura of the sort witnessed from hæmorrhagic small-pox. This consists in an essential difference anatomically of the skin lesions in the two classes of cases, a difference illustrated in a series of plates contributed by him and which may be consulted at the end of this volume.

[illegible]

In the report of your Medical Officer for last year Dr. [illegible] described in detail experiments by means of [illegible] employment of carbonic oxide gas [illegible] on shipboard. His procedure, it will be [illegible] so far as an empty vessel [illegible] was concerned, and accordingly he was [illegible] of rat [illegible] and remaining [illegible] In his further report [illegible] the matter con- [illegible] He discusses the dis- [illegible]

prepared air through the interior of loaded vessels of various descriptions, the arrangements requisite for supplying and distributing the poisonous air, and the construction, as well as the capacity desirable, of an apparatus to be designed for the above purposes.

MEDICAL OFFICERS' REPORT.

VACCINE LYMPH AND EXTRANEOUS MICRO-ORGANISMS.

As heretofore, and notwithstanding extra pressure of current work owing to small-pox prevalence, the Board's expert staff at the lymph laboratories has not neglected opportunity of enlarging our knowledge on matters interesting and important from the point of view of lymph cultivation and preservation. Dr. Blaxall submits in Appendix C, No. 1, a note on Equine Variola, samples of material from which malady were supplied him in the course of the year by Mr. Ernest Crompton, of Newmarket. Mr. Fremlin furnishes a report (Appendix C, No. 2) on a useful modification which he has devised of the Buchner-Klein method of cultivating anaërobic bacteria; and Dr. Alan Green, in a further report (Appendix C, No. 3) on the germicidal action of various substances on the micro-organisms, specific and extraneous, of vaccine lymph, affords strong presumption that we are likely to obtain in chloroform, as applied by the methods devised by him, an agency not only more potent but infinitely more speedy than glycerine in eliminating from our vaccine lymph undesirable micro-organisms.

I have the honour to be,

Sir,

Your obedient Servant,

W. H. POWER.

APPENDICES.

APPENDIX A.

No. 1.

Digest of the Vaccination Officers' Returns with regard to Children whose Births were registered in the Year 1899.

The following is a summary of the twenty-eighth annual return under the Vaccination Act, 1871 :—Of 929,189 births returned to the Board by the several vaccination officers in England and Wales as registered during the year 1899, the number which, at the time the return was made, had been registered as successfully vaccinated was 617,113 (being 66·4 per cent. of the whole), and the number registered as having died unvaccinated was 113,516 (or 12·2 per cent. of the whole). Of the remaining 198,560 children, 5,379 (or 0·6 per cent. of the whole) had been registered as insusceptible of vaccination ; 4 as having contracted small-pox ; 16,605 (or 1·8 per cent.) as having their vaccination postponed by medical certificate ; and 33,573 (or 3·6 per cent.) in respect of whom certificates of conscientious objection were received ; leaving 142,999 (or 15·4 per cent.) as "removed" "not to be traced" or otherwise unaccounted for. If from the 929,189 births returned by these officers deduction be first made of the deaths that took place before vaccination, it appears that, of the surviving 815,673 children, there were registered at the time of the return 75·7 per cent. as successfully vaccinated : 0·7 per cent. as either insusceptible of vaccination, or as having had small-pox ; 2 per cent. as under medical certificate of postponement ; and 4·1 per cent. in respect of whom certificates of conscientious objection to vaccination had been obtained ; leaving 17·5 per cent. as at that time still unaccounted for as regards vaccination.

APP. A, No 1.

Digest of Vaccination Officers' Returns. 1899.

The proportion of cases unaccounted for in the metropolitan returns for 1899 is 27·7 per cent.; in the provincial returns 15·4. Of the registered births of the twenty-eight years, 1872–99; the proportion not finally accounted for in regard to vaccination (including cases postponed) in each year respectively has been as follows:—

—	Metropolis.	Rest of England.	—	Metropolis.	Rest of England.
1872	8·8	4·5	1886	7·8	6·1
1873	8·7	4·2	1887	9·0	6·7
1874	8·8	4·1	1888	10·3	8·2
1875	9·3	3·8	1889	11·6	9·6
1876	6·5	4·0	1890	13 9	10·9
1877	7·1	4·1	1891	16·4	12·9
1878	7·1	4·3	1892	18·4	14·3
1879	7·8	4·5	1893	18·2	15·7
1880	7·0	4·5	1894	20·6	19·0
1881	5 7	4·3	1895	24·9	19·8
1882	6·6	4·5	1896	26·4	22·3
1883	6 5	4·9	1897	29·1	21·6
1884	6·8	5·3	1898	33·0	19·6
1885	7·0	5·5	1899	27·7	15·4

In 1899, the proportion of cases unaccounted for, excluding the postponed cases in the Metropolis, and in the rest of England, was 26·0 and 13·6 per cent. respectively.

Returns, 1899.

—	Births.	Successfully Vaccinated.	Insusceptible of Vaccination.	Had Small-pox.	Number in respect of whom Certificates of conscientious objection have been received.	Died unvaccinated.	Vaccination postponed.	Remaining.	Children not finally accounted for (including cases postponed), per cent. of births.		Total number of Certificates of Successful Primary Vaccination at ALL AGES received during each of the calendar years 1899 and 1900.	
									1899.	1898.	1899.	1900.
ENGLAND AND WALES	929,189	617,113	5,379	4	33,573	113,516	16,605	142,999	17·2	21·5	696,151	676,807
DIVISIONS.												
London	133,152	78,248	785	—	1,362	15,906	2,189	34,663	27·7	33·0	89,941	86,591
South Eastern	80,324	57,594	478	2	3,242	8,253	1,413	9,342	13·4	17·2	63,818	62,814
South Midland	56,943	34,497	270	—	4,149	5,951	754	11,322	21·2	26·1	40,767	37,881
Eastern	52,279	34,272	238	—	2,924	5,757	1,116	7,972	17·4	25·3	36,915	37,498
South Western	47,000	32,831	229	—	2,536	4,745	1,147	5,522	14·3	19·6	37,387	36,774
West Midland	111,161	73,862	736	—	2,924	13,997	2,054	17,588	17·7	23·1	84,540	78,864
North Midland	59,896	29,199	275	—	5,296	8,105	1,296	15,727	26·4	31·7	36,266	33,676
North Western	154,423	109,417	966	—	4,884	21,057	2,315	15,784	11·7	15·3	122,186	123,039
York	103,531	72,941	886	2	3,419	12,469	1,557	12,257	13·3	16·7	84,436	77,247
Northern	69,286	47,824	354	—	2,075	9,137	1,753	8,153	14·3	18·8	51,371	51,046
Wales..	61,182	46,438	162	—	762	8,140	1,011	4,669	9·3	11·1	48,524	51,377

APP. A, No. 1.

Digest of Vaccination Officers' Returns, 1899.

APP. A, No. 1.

Digest of Vaccination Officers' Returns, 1899.

—	Returns, 1899.									Total number of Certificates of successful Primary Vaccination at ALL AGES received during each of the calendar years 1899 and 1900.	
	Births.	Successfully Vaccinated.	Insusceptible of Vaccination.	Had Small-pox.	Number in respect of whom Certificates of conscientious objection have been received.	Died unvaccinated	Vaccination postponed.	Remaining.	Children not finally accounted for (including cases postponed), per cent. of births	1899.	1900.
II.—South Eastern.											
Surrey (extra-metropolitan).	16,969	11,158	81	—	519	1,725	482	3,004	20·5	12,301	12,246
Kent (extra-metropolitan).	23,568	17,882	173	—	998	2,438	369	1,708	8·8	20,181	19,840
Sussex	13,867	9,205	72	—	976	1,383	262	1,969	16·1	10,213	10,018
Hampshire	19,010	14,993	129	2	500	2,005	231	1,150	7·3	16,157	16,313
Berkshire	6,910	4,356	23	—	249	702	69	1,511	22·9	4,966	4,397
	80,324	57,594	478	2	3,242	8,253	1,413	9,342	13·4	63,818	62,814
III.—South Midland.											
Middlesex (extra-metropolitan).	20,623	13,531	149	—	323	2,363	260	3,997	20·6	14,667	14,969
Hertfordshire	7,047	5,153	38	—	367	599	142	748	12·6	5,386	5,586
Buckinghamshire ..	4,391	2,855	12	—	682	382	72	388	10·5	4,358	3,029
Oxfordshire..	4,544	3,391	18	—	457	375	36	267	6·7	4,806	4,055
Northamptonshire ..	9,806	3,284	19	—	1,260	1,130	104	4,008	41·9	3,874	3,510
Huntingdonshire	1,217	999	5	—	54	107	6	46	4·3	1,326	979
Bedfordshire	4,330	1,435	7	—	784	528	34	1,542	36·4	1.771	1,456
Cambridgeshire	4,986	3,849	22	—	222	467	100	326	8·5	4,679	4,298
	56,943	34,497	270	—	4,149	5,951	754	11,322	21·2	40,767	37,881
IV.—Eastern.											
Essex	30,109	18,423	154	—	898	3,373	861	6,400	24·1	20,254	20,775
Suffolk	9,527	7,189	32	—	449	931	147	779	9·7	7,559	7,562
Norfolk	12,643	8,660	52	—	1,577	1,453	108	793	7·1	9,102	9,161
	52,279	34,272	238	—	2,924	5,757	1,116	7,972	17·4	36,915	37,498

—	Returns, 1899. Births.	Successfully Vaccinated.	Insusceptible of Vaccination.	Had Small-pox.	Number in respect of whom Certificates of conscientious objection have been received.	Died unvaccinated.	Vaccination postponed.	Remaining.	Children not finally accounted for (including cases postponed), per cent. of births.	Total number of Certificates of successful Primary Vaccination at ALL AGES received during each of the calendar years 1899 and 1900. 1899.	1900.
V.—South Western.											
Wiltshire	6,724	3,853	29	—	1,005	584	165	1,088	18·6	4,366	4,143
Dorsetshire	4,805	3,746	12	—	162	324	68	493	11·7	4,293	3,932
Devonshire	16,328	12,216	101	—	269	1,811	397	1,534	11·8	12,304	13,413
Cornwall	7,755	5,454	33	—	175	890	149	1,054	15·5	7,634	7,333
Somersetshire	11,388	7,552	54	—	925	1,136	368	1,353	15·1	8,790	7,953
	47,000	32,821	229	—	2,536	4,745	1,147	5,522	14·3	37,387	36,774
VI.—West Midland.											
Gloucestershire	17,325	9,303	106	—	1,204	1,955	566	4,191	27·5	10,927	10,206
Herefordshire	2,805	2,286	11	—	66	250	68	144	7·6	2,361	2,441
Shropshire	6,722	5,508	23	—	90	628	84	389	7·0	6,578	6,006
Staffordshire	35,912	28,551	227	—	657	4,927	749	5,801	18·2	28,744	24,655
Worcestershire	20,215	15,088	171	—	387	2,276	357	1,986	11·6	15,808	15,919
Warwickshire	28,182	18,196	198	—	520	3,961	230	5,077	18·8	20,122	19,637
	111,161	73,862	736	—	2,924	13,997	2,054	17,588	17·7	84,540	78,864
VII.—North Midland.											
Leicestershire	12,852	2,443	11	—	1,986	1,933	156	6,343	50·6	3,194	3,478
Rutlandshire	489	421	6	—	27	29	—	6	1·2	510	429
Lincolnshire	13,339	8,703	96	—	1,477	1,603	279	1,181	10·9	11,226	9,939
Nottinghamshire	18,549	10,100	115	—	1,300	2,690	562	3,782	23·4	11,918	11,927
Derbyshire	14,669	7,532	47	—	526	1,850	299	4,415	32·1	9,419	7,903
	59,898	29,199	275	—	5,296	8,105	1,296	15,727	28·4	36,266	33,676
VIII.—North Western.											
Cheshire	21,498	17,411	146	—	284	2,487	349	821	5·4	18,840	18,886
Lancashire	132,925	92,006	820	—	4,600	18,570	1,966	14,963	12·7	103,346	104,153
	154,423	109,417	966	—	4,884	21,057	2,315	15,784	11·7	122,186	123,039

APP. A, No. 1.

Digest of Vaccination Officers' Returns, 1899.

—	Births.	Successfully Vaccinated.	Insusceptible of Vaccination.	Had Small-pox.	Number in respect of whom Certificates of conscientious objection have been received.	Died unvaccinated.	Vaccination postponed.	Remaining.	Children not finally accounted for (including cases postponed), per cent. of births.	Total number of Certificates of successful Primary Vaccination at ALL AGES received during each of the calendar years 1899 and 1900. 1899.	1900.
	RETURNS, 1899.										
II.—SOUTH EASTERN.											
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Kent (extra-metropolitan).	23,568	17,882	173	—	998	2,438	369	1,708	8·8	20,181	19,840
Sussex	13,867	9,205	72	—	976	1,383	262	1,969	16·1	10,213	10,018
Hampshire	19,010	14,993	129	2	500	2,005	231	1,150	7·3	16,157	16,313
Berkshire	6,910	4,356	23	—	249	702	69	1,511	22·9	4,966	4,397
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Staffordshire	35,912	28,551	227	—	667	4,927	749	5,801	18·2	28,744	24,655
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	Births.	Successfully Vaccinated.	Insusceptible of Vaccination.	Had Small-pox.	Number in respect of whom Certificates of conscientious objection have been received.	Died unvaccinated.	Vaccination postponed.	Remaining.	Children not finally accounted for (including cases postponed), per cent. of births.	1899.	1900.
IX.—York.											
West Riding	78,856	54,387	737	—	2,870	9,599	1,164	10,099	14·3	60,572	58,065
East Riding (with York)	13,659	10,459	85	2	142	1,491	143	1,337	10·8	15,045	10,734
North Riding	11,016	8,095	64	—	407	1,379	250	821	9·7	8,819	8,448
	103,531	72,941	886	2	3,419	12,469	1,557	12,257	13·3	84,436	77,247
X.—Northern.											
Durham	40,981	27,936	238	—	1,134	5,624	1,074	4,975	14·8	30,761	29,902
Northumberland . ..	19,120	13,126	93	—	468	2,613	432	2,388	14·7	12,998	14,088
Cumberland	7,659	5,478	16	—	418	765	228	754	12·8	6,132	5,708
Westmorland .. .	1,536	1,284	7	—	55	135	19	36	3·6	1,480	1,348
	69,296	47,824	354	—	2,075	9,137	1,753	8,153	14·3	51,371	51,046
XI.—Welsh.											
Monmouthshire	9,922	6,914	29	—	430	1,314	262	973	12·4	7,782	7,661
South Wales.. .. / North Wales.. ..	51,260	39,524	133	—	332	6,826	749	3,696	8·7	40,742	43,716
	61,182	46,438	162	—	762	8,140	1,011	4,669	9·3	48,521	51,377

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ENGLAND AND WALES.	929,189	617,113	5,379	4	33,573	113,516	16,605	142,999	17·2	696,151	676,807
Ditto (excluding Metropolitan Unions).	796,037	538,865	4,594	4	32,211	97,611	14,416	108,336	15·4	606,210	590,216
METROPOLITAN UNIONS.	133,152	78,248	785	..	1,362	15,905	2,189	34,663	27·7	89,941	86,591
COUNTIES.											
ENGLAND:											
Bedford	4,330	1,435	7	..	784	528	34	1,542	36·4	1,771	1,456
Berks	6,910	4,356	23	..	249	702	69	1,511	22·9	4,966	4,397
Buckingham ..	4,391	2,855	12	..	682	382	72	388	10·5	4,358	3,029
Cambridge ..	4,986	3,849	22	..	222	467	100	326	8·5	4,679	4,298
Chester	21,498	17,411	146	..	284	2,487	349	821	5·4	18,840	18,886
Cornwall ..	7,755	5,454	33	..	175	890	149	1,054	15·5	7,634	7,333
Cumberland ..	7,659	5,478	16	..	418	765	228	754	12·8	6,132	5,708
Derby	14,669	7,532	47	..	526	1,850	299	4,415	32·1	9,419	7,903
Devon	16,328	12,216	101	..	269	1,811	397	1,534	11·8	12,304	13,413
Dorset	4,805	3,746	12	..	162	324	68	493	11·7	4,293	3,932
Durham	40,981	27,936	238	..	1,134	5,624	1,074	4,975	14·8	30,761	29,902
Essex	30,109	18,423	154	..	898	3,373	861	6,400	24·1	20,254	20,775
Gloucester ..	17,325	9,303	106	..	1,204	1,955	566	4,191	27·5	10,927	10,206
Hereford ..	2,805	2,266	11	..	66	250	68	144	7·6	2,361	2,441
Hertford ..	7,047	5,153	38	..	367	599	142	748	12·6	5,386	5,585
Huntingdon ..	1,217	999	5	..	54	107	6	46	4·3	1,226	979
Kent (extra-metropolitan.)	23,568	17,882	173	..	998	2,438	369	1,708	8·8	20,181	19,840
Lancaster ..	132,925	92,006	820	..	4,600	18,570	1,966	14,963	12·7	103,346	104,153
Leicester ..	12,852	2,443	11	..	1,966	1,233	156	6,343	50·6	3,191	3,478
Lincoln	13,339	8,703	96	..	1,477	1,603	279	1,181	10·9	11,225	9,939
Middlesex (ex-metropolitan.)	20,623	13,531	149	..	323	2,363	260	3,997	20·6	14,667	14,969
Monmouth ..	9,922	6,914	29	..	430	1,314	262	973	12·4	7,782	7,601
Norfolk	12,643	8,660	52	..	1,577	1,453	108	793	7·1	9,102	9,161
Northampton ..	9,805	3,284	19	..	1,260	1,130	104	4,008	41·9	3,874	3,510
Northumberland	19,120	13,126	93	..	468	2,613	432	2,388	14·7	12,998	14,068

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Counties—*cont.*											
England—*cont.*											
Nottingham ..	18,549	10,100	115	..	1,300	2,690	562	3,782	23·4	11,918	11,927
Oxford	4,541	3,391	18	..	457	375	36	267	6·7	4,806	4,055
Rutland	489	421	6	..	27	29	..	6	1·2	510	429
Salop	6,722	5,508	23	..	90	628	84	389	7·0	6,578	6,006
Somerset ..	11,388	7,552	51	..	925	1,136	368	1,353	15·1	8,790	7,953
Southampton ..	19,010	14,993	129	2	500	2,005	231	1,150	7·3	16,157	16,313
Stafford	35,912	23,551	227	..	657	4,927	749	5,801	18·2	28,744	24,655
Suffolk	9,527	7,189	32	..	449	931	147	779	9·7	7,559	7,562
Surrey (extra-metropolitan.)	16,969	11,158	81	..	519	1,725	482	3,004	20·5	12,301	12,246
Sussex	13,867	9,205	72	..	976	1,383	262	1,969	16·1	10,213	10,018
Warwick ..	28,182	18,196	198	..	520	3,961	230	5,077	18·8	20,122	19,637
Westmorland ..	1,536	1,284	7	..	55	135	19	36	3·6	1,480	1,348
Wilts	6,724	3,853	29	..	1,005	584	165	1,088	18·6	4,366	4,143
Worcester ..	20,215	15,038	171	..	387	2,276	357	1,986	11·6	15,808	15,919
York, E. Riding	13,659	10,459	85	2	142	1,491	143	1,337	10·8	15,045	10,734
York, N. Riding	11,016	8,095	64	..	407	1,379	250	821	9·7	8,819	8,448
York, W. Riding	78,856	54,387	737	..	2,870	9,599	1,164	10,099	14·3	60,572	58,065
Wale											
Anglesey ..	909	783	..	..	1	97	10	18	3·1	878	678
Brecknock ..	1,496	1,121	1	..	23	167	22	159	12·1	1,182	1,458
Cardigan ..	1,475	1,244	1	..	18	166	19	27	3·1	1,573	1,315
Carmarthen ..	3,984	3,373	4	..	13	511	38	45	2·1	3,228	3,733
Carnarvon ..	3,568	2,956	11	..	18	429	31	123	4·3	3,009	3,628
Denbigh.. ..	2,903	2,453	16	..	6	318	39	71	3·8	2,888	2,635
Flint	2,422	2,050	3	..	2	252	47	68	4·7	2,148	2,169
Glamorgan ..	28,369	20,598	87	..	222	4,258	448	2,756	11·3	20,565	22,961
Merioneth ..	1,707	1,356	1	..	6	205	26	113	8·1	1,328	1,416
Montgomery ..	1,649	1,386	5	..	4	166	16	72	5·3	1,485	1,379
Pembroke ..	2,195	1,830	4	..	6	219	49	87	6·2	1,997	2,003
Radnor	583	371	..	..	13	38	4	157	27·6	461	341

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Bethnal Green	4,748	1,830	1	..	18	630	17	2,252	47·8	1,967	2,031
Camberwell	7,444	4,477	20	..	84	731	175	1,957	28·6	5,361	4,619
Chelsea	2,382	1,765	24	..	27	238	25	303	13·8	1,978	1,845
Fulham	4,581	3,360	27	..	66	615	76	437	11·2	3,447	3,754
George, St., Hanover Square.	2,458	1,944	21	..	25	272	27	169	8·0	2,073	1,984
George, St., in the East	2,063	1,102	..	..	2	239	..	720	34·9	1,533	1,498
Giles, St., and St. George	1,124	658	6	..	8	89	4	359	32·3	684	621
Greenwich	5,682	4,138	41	..	61	697	70	675	13·1	4,400	4,392
Hackney	7,249	3,506	34	..	68	908	39	2,694	37·7	4,945	4,371
Hammersmith	3,061	2,317	28	..	56	359	30	272	9·9	2,467	2,509
Hampstead	1,577	1,238	37	..	31	140	25	106	8·3	1,351	1,355
Holborn	4,590	2,518	20	..	47	593	125	1,287	30·8	2,496	2,568
Islington	9,651	5,698	81	..	101	1,048	333	2,390	28·2	6,894	6,152
Kensington	3,584	2,804	38	..	31	376	23	312	9·3	3,412	3,068
Lambeth	9,426	5,825	47	..	114	1,174	117	2,149	24·0	7,616	6,375
Lewisham	3,074	2,019	35	..	60	328	7	625	20·6	2,371	2,310
London, City of	430	305	2	..	10	44	7	62	16·0	350	326
Marylebone	3,992	2,721	30	..	28	405	105	703	20·2	3,046	3,189
Mile End Old Town ..	4,276	797	10	..	20	480	..	2,969	69·4	904	1,004
Olave, St.	4,694	2,939	15	..	35	629	..	1,076	22·9	4,136	3,375
Paddington	2,933	2,167	17	..	39	319	47	344	13·3	2,261	2,224
Pancras, St.	6,621	3,333	57	..	61	837	241	2,092	35·2	3,178	3,682
Poplar	5,930	2,113	12	..	28	838	18	2,921	49·6	2,185	2,479
Shoreditch	4,141	1,354	5	..	10	612	136	2,024	52·2	1,565	1,479
Southwark	6,997	3,825	28	..	47	1,024	8	2,065	29·6	4,520	4,106
Stepney*	1,937	750	3	..	6	276	8	894	46·6	1,081	789
Strand	350	225	2	..	..	54	7	62	19·7	249	266
Wandsworth and Clapham.	10,715	6,716	96	..	183	1,211	468	2,041	23·4	7,324	8,074
Westminster	708	536	3	..	8	64	2	95	13·7	783	546
Whitechapel	2,998	2,259	16	..	13	288	28	394	14·1	2,211	2,433
Woolwich	3,736	3,009	29	..	76	387	21	214	6·3	3,204	3,167
	133,152	78,248	785	..	1,362	15,906	2,189	34,663	27·7	89,941	86,591

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BEDFORD.											
Ampthill	536	328	1	..	69	38	1	99	18·7	393	316
Bedford	1,321	283	3	..	23	181	10	821	62·9	206	253
Biggleswade	695	488	1	..	121	57	4	24	4·0	510	505
Leighton Buzzard ..	431	229	1	..	122	46	6	27	7·7	536	262
Luton	1,347	107	1	..	449	206	13	571	43·4	126	120
	4,330	1,435	7	..	784	528	34	1,542	36·4	1,771	1,456
BERKS											
Abingdon	422	349	..	..	12	37	2	22	5·7	375	352
Bradfield	395	301	2	..	24	33	..	35	8·9	317	360
Easthampstead	323	279	1	..	7	21	1	14	4·6	381	314
Faringdon..	330	251	3	..	4	39	5	28	10·0	251	258
Hungerford and Ramsbury.	429	373	..	..	4	38	5	9	3·3	393	315
Maidenhead	570	399	1	..	70	53	6	41	8·2	599	417
Newbury	458	374	4	..	16	36	10	18	6·1	485	383
Reading	1,888	385	5	..	62	265	5	1,166	62·0	409	387
Wallingford	320	276	2	..	7	22	3	10	4·1	309	289
Wantage	383	317	..	..	10	38	10	8	4·7	400	302
Windsor	997	774	5	..	27	81	15	95	11·0	769	668
Wokingham	395	278	..	..	6	39	7	65	18·2	278	332
	6,910	4,356	23	..	249	702	69	1,511	22·9	4,966	4,397
BUCKINGHAM.											
Amersham	519	306	..	..	93	48	8	64	13·9	457	292
Aylesbury..	608	487	1	..	44	56	11	10	3·5	418	449
Buckingham	242	176	2	..	33	19	4	8	5·0	244	172
Eton	859	678	2	..	20	86	26	47	8·5	725	728
Newport Pagnell ..	723	487	3	..	164	43	2	24	3·6	850	502
Winslow	168	89	2	..	53	12	5	7	7·1	245	136
Wycombe	1,272	632	2	..	275	119	16	228	19·2	1,419	750
	4,391	2,856	12	..	682	382	72	388	10·5	4,358	3,029
CAMBRIDGE.											
Cambridge	868	588	8	..	28	112	5	127	15·2	674	769
Caxton and Arrington	208	169	..	..	20	13	..	6	2·9	217	150
Chesterton	745	626	1	..	29	57	8	24	4·3	753	773
Ely	511	402	7	..	38	41	4	19	4·5	730	509
Linton	253	208	..	..	4	20	7	14	8·3	221	224
Newmarket	871	647	4	..	32	78	51	59	12·6	605	673
North Witchford ..	473	383	..	..	47	32	3	8	2·3	451	361
Whittlesey	245	199	..	..	3	25	5	13	7·3	245	177
Wisbech	812	627	2	..	21	89	17	56	9·0	783	662
	4,986	3,849	22	..	222	467	100	326	8·5	4,679	4,298

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CHESTER											
Birkenhead	4,940	4,181	29	..	4	563	78	95	3·5	4,208	4,211
Bucklow	1,920	1,563	41	..	29	227	20	40	3·1	1,689	1,800
Chester	1,397	1,120	5	..	10	179	23	60	5·9	1,175	1,334
Congleton	923	725	3	..	10	92	35	58	10·1	767	961
Macclesfield	1,446	1,228	6	..	16	151	23	22	3·1	1,447	1,310
Nantwich	2,266	1,724	14	..	87	237	49	155	9·0	1,992	1,985
Northwich	1,746	1,547	9	..	12	161	1	16	1·0	1,664	1,563
Runcorn	1,170	993	7	..	14	129	19	8	2·3	1,062	1,066
Stockport	4,119	2,979	23	..	94	621	82	320	9·8	3,417	3,225
Tarvin	385	336	2	..	3	33	1	10	2·9	400	368
Wirral	1,186	1,015	7	..	5	104	18	37	4·6	1,019	1,063
	21,496	17,411	146	..	284	2,487	349	821	5·4	18,840	18,886
CORNWALL.											
Austell, St.	926	706	9	..	22	115	12	63	8·0	1,092	816
Bodmin	437	351	4	..	4	43	4	31	8·0	351	407
Camelford	196	174	..	..	7	7	..	8	4·1	236	147
Columb Major, St. ..	384	285	4	..	8	41	22	24	12·0	381	380
Falmouth	565	274	1	..	30	84	20	156	31·2	298	1,327
Germans, St.	481	415	3	..	1	42	6	14	4·2	440	444
Helston	487	342	1	..	12	48	9	75	17·2	426	405
Launceston	309	264	1	..	13	22	2	7	2·9	284	284
Liskeard	563	436	1	..	27	46	9	44	9·4	590	448
Penzance	1,272	965	2	..	11	161	19	114	10·5	1,203	999
Redruth	1,195	647	1	..	12	178	29	328	29·9	647	798
Stratton	176	119	..	..	..	16	..	41	23·3	147	129
Truro	764	476	6	..	28	87	17	150	21·9	1,539	749
	7,755	5,454	33	..	175	890	149	1,054	15·5	7,634	7,333
CUMBERLAND.											
Alston-with-Garrigill ..	73	50	..	..	13	5	3	2	6·8	50	40
Bootle	476	397	2	..	2	49	6	20	5·5	489	469
Brampton	216	158	..	..	6	17	10	25	16·2	210	184
Carlisle	1,682	1,437	2	..	21	165	18	39	3·4	1,590	1,592
Cockermouth	2,177	897	5	..	283	225	164	603	35·2	1,007	934
Longtown	169	132	1	..	2	23	..	11	6·5	132	120
Penrith	562	476	1	..	25	51	6	3	1·6	558	459
Whitehaven	1,706	1,434	4	..	52	163	10	43	3·1	1,557	1,427
Wigton	596	497	1	..	14	67	11	8	3·2	539	483
	7,659	5,478	16	..	418	765	228	754	12·8	6,132	5,708
DERBY.											
Ashbourne	576	401	1	..	16	60	11	87	17·0	441	500
Bakewell	836	642	2	..	57	62	13	60	8·7	876	648
Belper	2,166	1,340	13	..	116	244	43	410	20·9	2,026	1,404
Chapel-en-le-Frith ..	634	504	2	..	8	65	15	40	8·7	693	658
Chesterfield	4,697	2,651	13	..	90	616	140	1,187	28·3	2,799	2,607
Derby	3,000	466	4	..	37	493	..	2,000	66·7	784	432
Glossop	612	348	4	..	124	57	31	48	12·9	490	364
Hayfield	338	270	1	..	4	29	5	29	10·1	354	295
Shardlow	1,810	910	7	..	74	224	41	554	32·9	956	995
	14,669	7,532	47	..	526	1,850	299	4,415	32·1	9,419	7,903

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DEVON.											
Axminster	352	298	..	..	2	29	3	20	6·5	335	290
Barnstaple	1,041	820	6	..	44	102	20	49	6·6	855	882
Bideford	567	449	..	..	22	60	27	9	6·3	437	448
Crediton	388	362	..	..	2	20	1	3	1·0	383	325
Devonport	1,927	1,115	17	..	5	236	88	466	28·7	623	1,503
East Stonehouse ..	500	391	3	..	2	63	6	35	8·2	391	353
Exeter	843	590	11	..	37	126	44	35	9·4	636	716
Holsworthy	232	195	1	..	6	23	3	4	3·0	208	202
Honiton	466	409	2	..	7	39	..	9	1·9	424	396
Kingsbridge	359	311	2	..	8	28	1	9	2·8	356	321
Newton Abbot	1,588	1,291	11	..	43	177	30	36	4·2	1,498	1,335
Okehampton	361	296	1	..	6	31	9	18	7·5	228	322
Plymouth..	3,010	1,681	11	..	13	491	86	728	27·0	1,715	2,563
Plympton St. Mary ..	490	417	2	..	1	47	4	19	4·7	362	535
South Molton	369	328	1	..	..	33	5	2	1·9	323	255
Tavistock	587	505	6	..	29	37	4	6	1·7	609	516
Thomas, St.	1,285	1,047	19	..	16	106	51	46	7·5	1,047	1,038
Tiverton	699	587	2	..	14	71	10	15	3·6	665	570
Torrington	288	251	1	..	7	18	3	8	3·8	282	275
Totnes	976	873	5	..	5	74	2	17	1·9	927	868
	16,328	12,216	101	..	269	1,811	397	1,534	11·8	12,304	13,413
DORSET.											
Beaminster	261	225	..	..	1	18	3	4	2·8	226	222
Blandford..	264	194	1	..	18	20	16	15	11·7	278	183
Bridport	307	266	1	..	5	28	..	7	2·3	282	254
Cerne	116	101	..	..	3	9	..	3	2·6	109	115
Dorchester	444	334	..	..	14	39	6	51	12·8	428	287
Poole	901	644	5	..	54	94	28	76	11·5	883	876
Shaftesbury	259	221	..	..	9	14	4	11	5·8	270	230
Sherborne..	255	214	1	..	..	19	2	19	8·2	222	234
Sturminster	213	181	2	..	3	20	2	5	3·3	194	189
Wareham and Purbeck	406	354	2	..	15	26	2	7	2·2	420	347
Weymouth	968	544	..	..	33	100	..	281	29·3	516	653
Wimborne and Cranborne.	431	368	..	..	7	37	5	14	4·4	465	342
	4,805	3,746	12	..	162	324	68	493	11·7	4,293	3,932
DURHAM.											
Auckland	3,343	2,193	23	..	214	502	109	302	12·3	2,773	2,225
Chester-le-Street ..	2,283	1,726	14	..	13	340	41	149	8·3	2,119	1,796
Darlington	1,539	845	7	..	36	188	82	381	30·1	722	1,134
Durham	2,381	1,713	25	..	98	322	89	134	9·4	1,825	1,690
Easington..	1,792	1,496	8	..	21	211	16	40	3·1	1,600	1,636
Gateshead..	6,123	3,039	25	..	397	848	100	1,714	29·6	3,202	2,892
Hartlepool	2,934	2,348	17	..	46	384	60	79	4·7	2,377	2,422
Houghton-le-Spring ..	1,503	1,147	30	..	8	220	20	78	6·5	1,242	1,325
Lanchester	2,919	2,023	22	..	126	379	134	235	12·6	2,156	2,189
Sedgefield..	766	649	3	..	10	87	4	13	2·2	714	614
South Shields	5,800	3,849	25	..	32	829	225	1,040	21·8	3,904	4,211
Stockton	2,124	1,639	5	..	63	281	10	126	6·4	1,797	1,900
Sunderland	6,501	4,706	34	..	35	924	173	629	12·3	5,255	4,923
Teesdale	539	398	..	..	17	72	7	45	9·6	641	601
Weardale	434	365	..	..	18	37	4	10	3·2	434	344
	40,981	27,936	238	..	1,134	5,624	1,074	4,975	14·8	30,761	29,902

APP. A, No. 1.

Digest of Vaccination Officers' Returns, 1899.

—	RETURNS, 1899. Births.	Successfully Vaccinated.	Insusceptible of Vaccination.	Had Small-pox.	Number in respect of whom Certificates of conscientious objection have been received.	Died unvaccinated.	Vaccination postponed.	Remaining.	Children not finally accounted for (including cases postponed), per cent. of births.	Total number of Certificates of successful Primary Vaccination at ALL AGES received during each of the calendar years 1899 and 1900. 1899.	1900.
ESSEX.											
Billericay	458	351	4	..	20	46	2	35	8·1	438	414
Braintree	617	432	1	..	13	44	49	78	20·6	423	444
Chelmsford	841	713	..	..	38	59	5	26	3·7	828	763
Colchester	986	445	3	..	32	101	2	403	41·1	417	626
Dunmow	359	302	..	..	9	26	4	18	6·1	302	347
Epping	673	532	7	..	22	66	8	38	6·8	493	594
Halstead	407	323	..	..	35	28	5	16	5·2	377	290
Lexden and Winstree	562	475	1	..	27	30	3	26	5·2	467	473
Maldon	630	480	1	..	56	51	6	36	6·7	476	528
Ongar	244	205	..	..	..	26	..	13	5·3	212	166
Orsett	1,003	521	5	..	182	99	40	156	19·5	558	504
Rochford	1,279	792	3	..	106	136	25	217	18·9	689	1,031
Romford	2,606	1,703	18	..	41	294	58	492	21·1	1,784	2,031
Saffron Walden	362	318	3	..	7	24	3	7	2·8	379	324
Tendring	1,206	831	4	..	63	120	40	148	15·6	934	951
West Ham	17,876	10,000	104	..	247	2,223	611	4,691	29·7	11,477	11,289
	30,109	18,423	164	..	898	3,373	861	6,400	24·1	20,254	20,775
GLOUCESTER.											
Barton Regis	398	282	3	..	3	42	27	41	17·1	413	289
Bristol	9,352	4,935	74	..	161	1,170	366	2,646	32·2	5,073	5,808
Cheltenham	1,254	613	8	..	200	144	10	279	23·0	640	704
Chipping Sodbury	461	326	1	..	2	47	9	77	18·7	391	355
Cirencester	452	372	4	..	18	44	6	8	3·1	532	391
Dursley	274	163	4	..	32	21	5	49	19·7	265	168
Gloucester	1,671	642	2	..	234	214	49	530	34·8	771	625
Newent	240	193	..	..	11	15	7	14	8·8	251	186
Northleach	209	170	3	..	11	19	..	6	2·9	179	159
Stow-on-the-Wold	191	147	1	..	20	16	1	6	3·7	227	159
Stroud	915	411	2	..	166	83	29	224	27·7	807	345
Tetbury	137	104	..	..	18	11	..	4	2·9	162	115
Tewkesbury	323	81	..	..	66	35	13	128	43·7	81	32
Thornbury	405	328	2	..	32	23	7	13	4·9	338	373
Westbury-on-Severn	680	316	2	..	184	59	36	83	17·5	542	255
Wheatenhurst	126	58	..	..	..	2	..	66	52·4	58	75
Winchcomb	237	163	..	..	46	10	1	17	7·6	197	167
	17,325	9,303	106	..	1,204	1,955	566	4,191	27·5	10,927	10,206
HEREFORD.											
Bromyard	269	208	..	..	2	23	15	18	12·3	232	216
Dore	192	161	..	..	9	14	9	9	9·4	151	168
Hereford	833	650	2	..	17	86	24	55	9·5	750	639
Kington	250	202	2	..	8	23	7	8	6·0	193	326
Ledbury	352	299	..	..	5	26	3	20	6·5	267	315
Leominster	348	293	..	..	5	37	6	7	3·7	310	260
Ross	411	330	1	..	19	37	4	20	5·8	328	362
Weobley	150	133	6	..	1	3	..	7	4·7	135	156
	2,805	2,266	11	..	66	250	66	144	7·6	2,361	2,441

APP. A, No. 1.

Digest of Vaccination Officers' Returns, 1899.

—	Returns, 1899.									Total number of Certificates of successful Primary Vaccination at ALL AGES received during each of the calendar years 1899 and 1900.	
	Births.	Successfully Vaccinated.	Insusceptible of Vaccination.	Had Small-pox.	Number in respect of whom Certificates of conscientious objection have been received.	Died unvaccinated.	Vaccination postponed.	Remaining.	Children not finally accounted for (including cases postponed), per cent. of births.	1899.	1900.
HERTFORD.											
Albans, St.	786	364	..	..	116	76	3	227	29·3	185	528
Barnet	1,344	948	15	..	49	111	63	158	16·4	1,052	984
Berkhampstead	363	269	..	..	37	30	7	20	7·4	367	278
Bishop Stortford	516	413	..	..	24	49	9	21	5·8	353	490
Buntingford	108	97	3	..	1	5	..	2	1·9	119	106
Hatfield	206	182	2	..	3	12	..	7	3·4	196	177
Hemel Hempstead	439	235	2	..	33	51	..	118	26·9	259	295
Hertford	393	327	1	..	15	38	1	11	3·1	404	354
Hitchin	691	594	2	..	23	42	1	29	4·3	647	579
Royston	347	291	..	..	8	29	9	10	5·5	291	344
Ware	528	452	5	..	8	35	8	20	5·3	403	484
Watford	1,257	922	8	..	49	117	41	120	12·8	1,051	909
Welwyn	69	59	..	..	1	4	..	5	7·2	59	57
	7,047	5,153	38	..	367	599	142	748	12·6	5,386	5,585
HUNTINGDON.											
Huntingdon	509	409	2	..	29	43	5	21	5·1	459	382
Ives, St.	371	315	3	..	12	30	1	10	3·0	328	314
Neots, St.	337	275	..	..	13	34	..	15	4·5	439	283
	1,217	999	5	..	54	107	6	46	4·3	1,226	979
KENT (EXTRA-METROPOLITAN).											
Ashford, East	328	276	1	..	18	22	2	9	3·4	321	269
Ashford, West	486	374	..	..	37	47	7	21	5·8	280	440
Blean	551	425	2	..	23	63	5	33	6·9	490	523
Bridge	275	226	2	..	2	29	6	11	6·2	190	210
Bromley	1,993	1,501	17	..	55	209	11	200	10·6	1,707	1,700
Canterbury	488	384	8	..	7	48	..	41	8·4	391	392
Cranbrook	286	222	..	..	7	31	2	24	9·1	210	268
Dartford	2,672	2,130	23	..	100	305	25	89	4·3	2,347	2,577
Dover	1,314	1,057	10	..	22	146	8	71	6·0	1,212	1,145
Eastry	757	654	2	..	17	63	1	20	2·8	765	630
Elham	1,226	959	9	..	42	122	19	75	7·7	1,060	1,072
Faversham	731	621	8	..	16	70	3	13	2·2	651	663
Gravesend and Milton	711	354	3	..	4	97	..	253	35·6	375	338
Hollingbourn	292	238	1	..	2	17	7	27	11·6	245	284
Hoo	107	86	3	..	..	10	4	4	7·5	109	106
Maidstone	1,234	791	5	..	61	99	81	197	22·5	1,102	826
Malling	766	627	12	..	11	88	6	22	3·7	664	686
Medway	2,550	2,028	12	..	40	284	55	131	7·3	2,412	2,211
Milton	847	692	10	..	29	87	2	27	3·4	866	725
Romney Marsh	152	133	..	..	1	15	1	2	2·0	140	132
Sevenoaks	707	536	10	..	12	68	20	61	11·5	537	573
Sheppey	527	391	3	..	8	64	17	44	11·6	364	498
Strood	1,282	1,016	13	..	39	155	9	50	4·6	1,161	1,207
Tenterden	201	156	4	..	10	14	12	5	8·5	154	217
Thanet, Isle of	1,528	1,076	7	..	143	152	20	130	9·8	1,217	1,157
Tonbridge	1,557	930	8	..	292	133	46	148	12·5	1,211	991
	23,568	17,862	173	..	998	2,438	369	1,708	8·8	20,181	19,840

—	Returns, 1899. Births.	Successfully Vaccinated.	Insusceptible of Vaccination.	Had Small-pox.	Number in respect of whom Certificates of conscientious objection have been received.	Died unvaccinated.	Vaccination postponed.	Remaining.	Children not finally accounted for (including cases postponed), per cent. of births.	Total number of Certificates of successful Primary Vaccination at ALL AGES received during each of the calendar years 1899 and 1900. 1899.	1900.
LANCASTER.											
Ashton-under-Lyne ..	4,799	2,751	13	..	393	835	66	741	16·8	5,157	3,247
Barrow-in-Furness ..	1,706	1,453	15	..	15	184	13	26	2·3	1,496	1,619
Barton-upon-Irwell ..	2,902	1,891	18	..	42	382	174	395	19·6	2,014	2,128
Blackburn	6,312	4,805	16	..	199	865	97	330	6·8	5,503	5,737
Bolton	7,454	6,347	46	..	47	826	19	169	2·5	7,325	7,140
Burnley	5,608	2,305	28	..	785	879	139	1,472	28·7	2,664	2,918
Bury	3,646	2,031	18	..	535	491	25	546	15·7	3,621	2,195
Chorley	1,808	1,381	10	..	4	252	21	140	8·9	1,531	1,525
Chorlton	9,873	5,953	64	..	63	1,479	131	2,183	23·4	6,165	7,296
Clitheroe	531	409	1	..	16	47	27	31	10·9	488	406
Fylde, The	2,490	1,607	14	..	75	290	158	346	20·2	1,597	1,608
Garstang	294	267	..	..	1	18	..	8	2·7	286	236
Haslingden	2,804	1,895	12	..	321	322	50	204	9·1	2,052	2,285
Lancaster	1,764	1,347	3	..	11	243	17	143	9·1	1,453	1,436
Leigh	2,814	2,243	24	..	28	362	18	139	5·6	2,656	2,639
Liverpool	5,100	3,843	19	..	6	845	20	367	7·6	3,622	4,394
Lunesdale	188	132	1	..	..	17	..	18	10·7	137	165
Manchester	4,773	3,019	26	..	8	806	154	760	19·1	2,972	3,324
Oldham	5,789	2,689	26	..	1,150	852	2	1,070	18·5	3,103	3,082
Ormskirk	2,618	2,153	49	..	32	288	26	70	3·7	2,437	2,322
Prescot	5,300	4,358	41	..	28	598	29	246	5·2	5,080	4,761
Preston	4,451	2,941	28	..	30	819	55	578	14·2	3,603	3,659
Prestwich	5,915	4,339	59	..	47	715	85	670	12·8	4,804	4,912
Rochdale	2,841	1,398	12	..	442	402	5	582	20·7	442	1,531
Salford	7,649	5,166	39	..	76	1,188	124	1,056	15·4	6,272	5,794
Todmorden	986	700	11	..	119	91	7	58	6·6	965	751
Toxteth Park	4,194	2,826	39	..	5	611	157	556	17·0	2,955	3,076
Ulverston	1,062	936	8	..	3	106	3	6	0·8	1,029	1,015
Warrington	3 430	2,526	31	..	23	522	54	274	9·6	2,387	2,394
West Derby	16,858	12,868	118	..	21	2,258	215	1,378	9·4	12,833	14,695
Wigan	6,986	5,427	31	..	75	977	75	401	6·8	6,698	5,863
	132,925	92,006	820	..	4,600	18,570	1,966	14,963	12·7	103,346	104,153
LEICESTER.											
Ashby-de-la-Zouch ..	1,425	670	2	..	259	152	21	321	24·0	1,035	699
Barrow-on-Soar ..	730	111	..	..	263	115	6	235	33·0	141	169
Billesdon	120	74	2	..	17	10	..	17	14·2	74	83
Blaby	722	195	1	..	235	94	13	184	27·3	264	230
Hinckley	772	133	..	..	174	91	1	373	48·4	44	266
Leicester	6,274	219	4	..	167	1,168	..	4,716	75·2	219	466
Loughborough	989	223	..	..	432	116	95	123	22·0	300	222
Lutterworth	231	157	..	..	20	17	1	36	16·0	91	456
Market Bosworth ..	530	197	..	..	208	53	11	61	13·6	197	218
Market Harborough ..	450	123	1	..	52	34	4	236	53·3	123	223
Melton Mowbray ..	609	341	1	..	139	83	4	41	7·4	706	446
	12,852	2,443	11	..	1,966	1,933	156	6,343	50·6	3,194	3,478
LINCOLN.											
Boston	1,091	720	8	..	157	126	16	64	7·3	959	1,093
Bourne	455	284	..	..	9	54	..	108	23·7	334	338
Caistor	407	266	7	..	84	35	4	11	3·7	303	312
Gainsborough	1,037	455	2	..	251	133	40	156	18·9	598	381
Glanford Brigg	1,360	766	6	..	296	167	23	102	9·2	969	767
Grantham..	832	614	4	..	54	74	10	76	10·3	610	694

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Digest of Vaccination Officers' Returns, 1899.

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LINCOLN—*cont.*											
Grimsby	2,484	1,428	40	..	140	395	95	386	19·4	2,245	1,940
Holbeach	477	312	..	..	113	42	1	9	2·1	563	357
Horncastle	467	359	2	..	7	35	21	43	13·7	397	346
Lincoln	1,912	1,355	7	..	147	272	25	106	6·9	1,562	1,390
Louth	656	529	3	..	39	60	14	11	3·8	538	582
Sleaford	618	457	6	..	36	48	11	60	11·5	617	472
Spalding	564	356	2	..	118	55	11	22	5·9	560	469
Spilsby	595	508	7	..	4	63	4	9	2·2	660	518
Stamford	384	294	2	..	22	44	4	18	5·7	310	340
	13,339	8,703	96	..	1,477	1,603	279	1,181	10·9	11,225	9,939
MIDDLESEX (EXTRA-METROPOLITAN).											
Brentford	4,664	3,310	42	..	18	566	41	687	15·6	3,658	3,813
Edmonton	9,327	5,535	59	..	162	1,045	176	2,350	27·1	5,788	6,016
Hendon	1,321	911	9	..	45	155	9	192	15·2	1,066	1,014
Staines	923	741	2	..	8	81	6	85	9·9	792	795
Uxbridge	1,013	819	3	..	21	109	7	54	6·0	934	914
Willesden	3,375	2,215	34	..	69	407	21	629	19·3	2,409	2,417
	20,623	13,531	149	..	323	2,363	260	3,997	20·6	14,667	14,969
MONMOUTH.											
Abergavenny	707	478	3	..	62	90	9	65	10·5	642	516
Bedwellty..	2,844	1,886	2	..	22	459	105	370	16·7	1,912	2,408
Chepstow	531	354	..	..	50	58	7	62	13·0	539	350
Monmouth	770	460	1	..	120	67	11	111	15·8	460	653
Newport	3,688	2,712	23	..	129	477	88	259	9·4	3,065	2,838
Pontypool..	1,382	1,024	..	..	47	163	42	106	10·7	1,144	896
	9,922	6,914	29	..	430	1,314	262	973	12·4	7,782	7,661
NORFOLK.											
Aylsham	495	426	..	..	19	41	2	7	1·8	445	381
Blofield	285	240	..	..	19	22	..	4	1·4	257	266
Depwade	503	406	3	..	38	35	6	15	4·2	429	472
Docking	451	392	1	..	21	30	..	7	1·6	399	401
Downham	448	377	2	..	3	54	..	12	2·7	406	394
Erpingham	580	438	1	..	49	50	13	29	7·2	493	423
Faith, St.	331	250	..	..	37	25	6	13	5·7	250	265
Flegg, East and West ..	294	241	7	..	5	28	4	9	4·4	283	274
Forehoe	290	211	3	..	15	23	..	38	13·1	211	171
Freebridge Lynn ..	300	241	4	..	25	21	..	9	3·0	280	253
Guiltcross..	263	205	1	..	15	28	..	14	5·3	175	220
Henstead	262	209	..	..	18	25	..	10	3·8	296	227
King's Lynn	568	73	..	..	70	85	11	329	59·9	76	70
Loddon and Clavering	296	253	1	..	6	27	1	8	3·0	266	292
Mitford and Launditch	598	443	2	..	25	65	15	48	10·5	369	505
Norwich	3,293	1,599	15	..	1,044	514	5	116	3·7	1,484	1,509
Smallburgh	478	387	1	..	28	47	4	11	3·1	377	371
Swaffham..	265	217	..	..	6	23	6	13	7·2	244	196
Thetford	447	365	..	..	29	28	10	15	5·6	343	302
Walsingham	499	381	1	..	37	56	6	18	4·8	403	416
Wayland	234	186	..	..	13	22	5	8	5·6	171	195
Yarmouth, Great ..	1,463	1,120	10	..	56	204	14	60	5·1	1,465	1,552
	12,643	8,660	52	..	1,577	1,453	108	793	7·1	9,102	9,161

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NORTHAMPTON.											
Brackley	284	161	1	..	25	29	14	54	23·9	161	85
Brixworth	319	135	1	..	44	18	2	119	37·9	114	157
Daventry	412	227	1	..	46	35	10	93	25·0	370	252
Hardingstone	314	182	6	..	77	27	2	20	7·0	215	152
Kettering	1,537	194	1	..	145	242	24	931	62·1	194	348
Northampton	2,493	348	5	..	318	309	17	1,496	60·7	447	435
Oundle	215	180	1	..	6	16	1	11	5·6	180	184
Peterborough	1,497	1,135	..	..	36	160	..	166	11·1	1,151	1,199
Potterspury	317	198	..	..	70	33	..	16	5·0	338	219
Thrapston	404	161	..	..	172	34	5	32	9·2	190	163
Towcester	295	156	..	..	59	29	7	44	17·3	303	117
Wellingborough ..	1,718	207	3	..	262	198	22	1,026	61·0	211	199
	9,805	3,284	19	..	1,260	1,130	104	4,008	41·9	3,874	3,510
NORTHUMBERLAND.											
Alnwick	645	454	5	..	8	63	36	79	17·8	413	443
Belford	119	111	..	..	1	6	1	..	0·8	116	130
Bellingham	151	126	..	..	9	7	1	8	6·0	146	124
Berwick-upon-Tweed	522	447	..	..	..	58	8	9	3·3	524	444
Castle Ward	815	469	4	..	32	64	20	226	30·2	469	746
Glendale	187	165	..	..	1	15	3	3	3·2	171	134
Haltwhistle	234	137	..	..	70	21	5	1	2·6	89	130
Hexham	925	638	2	..	74	109	33	69	11·0	649	603
Morpeth	1,856	700	4	..	24	359	13	756	41·4	680	887
Newcastle-on-Tyne ..	7,780	5,790	36	..	101	1,075	56	722	10·0	5,305	6,197
Rothbury	135	124	1	..	..	9	1	..	0·7	126	124
Tynemouth	5,751	3,965	41	..	148	827	255	515	13·4	4,310	4,126
	19,120	13,126	93	..	468	2,613	432	2,388	14·7	12,998	14,088
NOTTINGHAM.											
Basford	5,213	2,770	44	..	489	666	159	1,085	23·9	3,358	3,004
Bingham	335	258	2	..	32	27	5	11	4·8	295	276
East Retford	670	535	8	..	30	57	6	34	6·0	565	515
Mansfield	2,964	1,410	8	..	72	512	67	895	32·5	2,019	2,068
Newark	761	439	3	..	15	91	4	209	29·8	440	467
Nottingham	6,864	3,417	34	..	614	1,122	308	1,369	24·4	4,060	4,197
Southwell	474	341	5	..	21	39	5	63	14·3	280	3 4
Worksop	1,268	930	11	..	27	176	8	116	9·8	901	1,036
	18,549	10,100	115	..	1,300	2,690	562	3,782	23·4	11,918	11,927
OXFORD.											
Banbury	753	382	1	..	219	59	3	89	12·2	1,448	745
Bicester	279	214	..	..	11	26	8	20	10·0	222	250
Chipping Norton ..	391	259	1	..	46	31	7	47	13·8	355	414
Headington	818	688	2	..	29	74	4	21	3·1	742	783
Henley	617	488	..	..	33	58	5	33	6·2	458	526
Oxford	560	460	2	..	24	52	2	20	3·9	570	489
Thame	302	234	3	..	30	27	..	8	2·6	264	232
Witney	487	391	6	..	33	37	6	14	4·1	426	374
Woodstock	337	275	3	..	32	11	1	15	4·7	321	243
	4,544	3,391	18	..	457	375	36	267	6·7	4,806	4,055

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RUTLAND.											
Oakham	268	235	3	..	11	16	..	3	1·1	276	256
Uppingham	221	186	3	..	16	13	..	3	1·4	234	173
	489	421	6	..	27	29	..	6	1·2	510	429
SALOP.											
Atcham	1,261	1,049	6	..	13	121	17	55	5·7	1,490	1,134
Bridgnorth	400	330	2	..	15	34	2	17	4·8	368	336
Church Stretton ..	110	104	..	..	..	5	..	1	0·9	95	116
Cleobury Mortimer ..	219	192	..	..	5	13	1	8	4·1	194	201
Clun	226	183	..	..	5	15	1	22	10·2	189	176
Drayton	332	285	3	..	4	30	5	5	3·0	276	294
Ellesmere	407	352	..	..	1	43	..	11	2·7	358	333
Ludlow	463	381	..	..	12	51	8	11	4·1	471	447
Madeley	686	577	..	..	8	67	13	21	5·0	629	632
Newport	324	268	3	..	..	34	3	16	5·9	320	309
Oswestry	734	640	5	..	6	66	6	11	2·3	716	656
Shifnal	294	241	1	..	1	29	6	16	7·5	241	280
Wellington	689	446	..	..	6	79	..	158	22·9	751	599
Wem	266	224	..	..	8	21	7	6	4·9	244	241
Whitchurch	311	236	3	..	6	20	15	31	14·8	236	252
	6,722	5,508	23	..	90	628	84	389	7·0	6,578	6,006
SOMERSET.											
Axbridge	977	499	2	..	159	100	31	186	22·2	762	501
Bath	1,710	1,047	10	..	91	195	155	212	21·5	1,113	1,266
Bridgwater	913	512	10	..	93	72	36	190	24·8	844	460
Chard	628	524	1	..	10	62	10	21	4·9	593	574
Clutton	732	522	1	..	72	72	13	52	8·9	629	560
Dulverton	112	100	..	..	6	6	..	..	0·0	100	87
Frome	541	407	..	..	62	43	5	24	5·4	412	555
Keynsham	1,111	542	..	..	45	142	21	361	34·4	538	456
Langport	316	248	..	..	27	26	5	10	4·7	426	281
Long Ashton	534	344	1	..	29	53	17	90	20·0	397	402
Shepton Mallet	415	259	2	..	64	45	5	40	10·8	261	300
Taunton	1,038	782	13	..	83	122	9	29	3·7	841	760
Wellington	450	357	3	..	40	35	1	14	3·3	421	347
Wells	548	357	4	..	37	48	26	76	18·6	311	296
Williton	357	291	..	..	15	38	8	5	3·6	334	281
Wincanton	323	243	..	..	17	30	6	17	10·2	230	259
Yeovil	683	518	7	..	75	47	20	16	5·3	578	568
	11,388	7,552	54	..	925	1,136	368	1,353	15·1	8,790	7,953
SOUTHAMPTON.											
Alresford	156	140	1	..	..	9	3	3	3·8	140	125
Alton	370	305	..	..	4	40	4	17	5·7	384	370
Alverstoke	780	648	10	..	1	92	1	28	3·7	648	704
Andover	421	291	2	..	53	45	10	20	7·1	375	311
Basingstoke	503	361	3	..	68	41	17	13	6·0	418	463
Catherington	41	37	..	..	1	2	..	1	2·4	50	56
Christchurch	1,334	826	5	..	16	162	9	316	24·4	742	931
Droxford	269	237	..	..	2	20	1	9	3·7	236	254
Fareham	486	412	2	..	2	45	3	22	5·1	455	418
Fordingbridge	176	144	1	..	15	11	..	5	2·8	138	115

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SOUTHAMPTON—*cont.*											
Hartley Wintney ..	678	562	3	..	7	62	7	37	6·5	672	550
Havant	276	235	1	..	5	21	4	10	5·1	286	254
Hursley	99	83	..	..	1	4	1	10	11·1	91	95
Kingsclere	221	196	1	..	8	15	..	1	0·5	201	198
Lymington	314	254	4	1	4	14	1	36	11·8	249	269
New Forest	331	280	..	..	2	24	3	22	7·6	310	380
Petersfield	274	220	..	..	10	25	4	15	6·9	222	260
Portsmouth	4,981	4,171	60	..	23	645	18	64	1·6	4,557	4,422
Ringwood	150	129	1	..	1	11	..	8	5·3	136	154
Romsey	267	224	..	..	18	19	1	5	2·2	183	270
Southampton	1,802	1,391	12	..	39	240	19	101	6·7	1,441	1,534
South Stoneham ..	2,247	1,632	14	1	53	219	63	265	14·6	1,711	1,774
Stockbridge	135	112	..	..	8	10	..	5	3·7	133	130
Whitchurch	169	132	..	..	3	17	9	8	10·1	132	134
Wight, Isle of	1,787	1,376	7	..	124	146	34	100	7·5	1,593	1,526
Winchester, New ..	743	595	2	..	32	66	19	29	6·5	654	616
	19,010	14,993	129	2	500	2,005	231	1,150	7·3	16,157	16,313
STAFFORD.											
Burton-upon-Trent ..	2,731	1,526	6	..	70	314	..	815	29·8	1,652	1,543
Cannock	1,704	1,391	4	..	27	188	11	83	5·5	2,243	1,329
Cheadle	727	605	2	..	9	67	8	36	6·1	725	646
Leek	1,242	1,005	1	..	51	144	17	24	3·3	1,166	1,163
Lichfield	1,279	1,053	15	..	15	138	17	41	4·5	1,078	1,092
Newcastle-under-Lyme	1,248	1,067	13	..	3	141	8	16	1·9	953	1,139
Seisdon	447	360	3	..	13	45	2	24	5·8	497	411
Stafford	831	676	4	..	36	68	13	34	5·7	800	661
Stoke-upon-Trent ..	5,455	3,528	31	..	21	964	225	686	16·7	3,262	4,158
Stone	463	381	1	..	4	48	7	22	6·3	291	633
Tamworth	735	505	2	..	15	68	14	131	19·7	491	510
Uttoxeter	400	346	..	..	5	29	2	18	5·0	371	345
Walsall	4,069	2,415	38	..	47	698	87	784	21·4	3,699	2,665
West Bromwich ..	5,572	2,846	38	..	97	793	183	1,615	32·3	4,431	2,589
Wolstanton and Burslem	3,625	2,734	16	..	11	489	33	342	10·3	3,182	2,809
Wolverhampton ..	5,384	3,113	53	..	233	733	122	1,130	23·3	3,903	2,962
	35,912	23,551	227	..	657	4,927	749	5,801	18·2	28,744	24,655
SUFFOLK.											
Blything	666	599	3	..	6	53	2	3	0·8	663	605
Bosmere and Claydon	344	266	1	..	20	36	6	15	6·1	267	289
Bury St. Edmunds ..	418	284	4	..	24	41	35	30	15·6	267	284
Cosford	389	354	..	..	4	22	2	7	2·3	386	314
Hartismere	370	324	2	..	7	22	5	10	4·1	376	293
Hoxne	287	246	1	..	7	23	..	10	3·5	304	268
Ipswich	1,780	777	..	..	258	288	33	424	25·7	639	987
Mildenhall	209	181	..	..	1	18	3	6	4·3	181	207
MutfordandLothingland	1,225	930	1	..	26	102	19	147	13·6	1,019	1,058
Plomesgate	550	457	1	..	17	45	9	21	5·5	500	456
Risbridge	444	381	2	..	12	42	3	4	1·6	408	350
Samford	309	274	1	..	..	28	2	4	1·9	329	307
Stow	530	449	6	..	18	41	3	13	3·0	449	440
Sudbury	673	568	1	..	21	57	7	19	3·9	609	530
Thingoe	360	311	3	..	6	30	3	7	2·8	311	329
Wangford	383	331	3	..	11	30	4	4	2·1	353	336
Woodbridge	590	457	3	..	11	53	11	66	11·2	498	514
	9,527	7,189	32	..	449	931	147	779	9·7	7,559	7,562

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SURREY (EXTRA-METROPOLITAN.											
Chertsey	938	716	4	..	17	85	5	111	12·4	825	773
Croydon	4,615	2,186	20	..	74	518	192	1,625	39·4	2,463	2,148
Dorking	330	232	..	..	37	31	10	20	9·1	320	315
Epsom	1,364	980	4	..	41	128	41	172	15·6	929	1,037
Farnham	1,595	1,263	10	..	28	153	10	131	8·8	1,593	1,257
Godstone	618	438	..	..	9	61	23	87	17·8	524	438
Guildford	1,456	1,025	9	..	105	138	89	90	12·3	1,333	1,076
Hambledon	489	395	5	..	20	46	3	20	4·7	435	436
Kingston	3,429	2,246	19	..	91	355	94	624	20·9	2,003	3,039
Reigate	985	710	2	..	84	95	14	80	9·5	871	782
Richmond	1,150	967	8	..	13	117	1	44	3·9	1,005	935
	16,969	11,158	81	..	519	1,725	482	3,004	20·5	12,301	12,246
SUSSEX.											
Battle	553	440	..	..	22	34	11	46	10·3	588	607
Brighton	2,578	1,610	14	..	51	355	33	515	21·3	1,839	1,773
Chichester	292	231	5	..	6	34	2	14	5·5	231	257
Cuckfield	527	435	1	..	23	42	7	19	4·9	520	512
Eastbourne	1,141	298	3	..	117	121	31	571	52·8	299	367
East Grinstead	461	274	1	..	31	28	34	93	27·5	283	236
East Preston	844	625	..	..	39	101	32	47	9·4	673	755
Hailsham	398	235	1	..	91	27	7	37	11·1	248	285
Hastings	1,310	936	14	..	120	125	9	106	8·8	1,171	985
Horsham	651	516	1	..	20	63	16	35	7·8	534	485
Lewes	492	173	1	..	150	35	20	113	27·0	188	160
Midhurst	326	295	1	..	3	21	1	5	1·8	274	306
Newhaven	309	161	..	..	49	40	3	56	19·1	161	187
Petworth	194	167	2	..	6	16	1	2	1·5	191	173
Rye	271	202	4	..	33	23	..	9	3·3	252	229
Steyning	1,823	1,335	18	..	49	191	26	204	12·6	1,270	1,408
Thakeham	186	161	1	..	4	14	..	5	2·7	149	151
Ticehurst	354	262	3	..	45	19	6	19	7·1	321	282
Uckfield	530	321	..	..	112	36	11	50	11·5	405	335
Westbourne	180	146	..	..	2	17	9	6	8·3	159	140
Westhampnett	448	382	2	..	3	41	3	17	4·5	457	385
	13,867	9,205	72	..	976	1,383	262	1,969	16·1	10,213	10,018
WARWICK.											
Alcester	537	458	1	..	32	34	4	8	2·2	549	490
Aston	10,435	7,203	106	..	44	1,540	116	1,426	14·8	7,990	7,981
Atherstone	588	300	3	..	12	60	25	188	36·2	303	296
Birmingham	8,598	5,638	60	..	28	1,439	47	1,386	16·7	6,111	5,799
Coventry	1,888	963	5	..	110	235	..	575	30·5	963	903
Foleshill	896	657	..	..	69	100	3	67	7·8	980	523
Meriden	239	147	1	..	6	26	1	58	24·7	88	206
Nuneaton	984	318	..	..	77	147	..	442	44·9	318	395
Rugby	864	95	..	..	14	83	1	671	77·8	95	239
Solihull	1,201	898	11	..	15	125	5	147	12·7	937	1,039
Southam	276	204	4	..	31	18	8	11	6·9	306	297
Stratford-on-Avon ..	488	356	..	..	28	46	8	50	11·9	262	479
Warwick	1,188	959	7	..	54	108	12	48	5·1	1,220	990
	28,182	18,196	198	..	520	3,961	230	5,077	18·8	20,122	19,637

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WESTMORLAND.											
East Ward	307	216	..	..	35	31	5	20	8·1	236	265
Kendal	1,016	897	6	..	13	80	8	12	2·0	1,055	901
West Ward	213	171	1	..	7	24	6	4	4·7	189	182
	1,536	1,284	7	..	55	135	19	36	3·6	1,480	1,348
WILTS.											
Amesbury..	175	139	1	..	14	11	1	9	5·7	140	129
Bradford-on-Avon ..	234	100	..	..	12	18	..	104	44·4	134	112
Calne	187	100	..	..	12	19	11	45	29·9	100	151
Chippenham	606	351	2	..	55	43	42	113	26·6	295	322
Cricklade and Wootton Bassett.	308	159	2	..	69	32	20	26	14·9	384	211
Devizes	481	259	6	..	95	47	16	58	15·4	263	263
Malmesbury	343	230	1	..	18	22	1	71	21·0	228	227
Marlborough	201	169	5	..	6	16	1	4	2·5	203	172
Mere	137	118	..	..	7	4	4	4	5·8	88	102
Pewsey	287	230	2	..	26	19	2	8	3·5	295	234
Salisbury	654	420	..	..	131	65	16	22	5·8	483	453
Swindon and Highworth.	1,750	805	5	..	483	172	27	258	16·3	835	833
Tisbury	190	145	2	..	3	14	2	24	13·7	139	159
Trowbridge and Melksham.	400	75	..	..	15	41	18	251	67·3	95	126
Warminster	267	220	..	..	16	26	..	5	1·9	270	235
Westbury and Whorwellsdown.	272	161	1	..	8	19	2	81	30·5	215	223
Wilton	232	172	2	..	35	16	2	5	3·0	199	191
	6,724	3,853	29	..	1,005	584	165	1,088	18·6	4,366	4,143
WORCESTER.											
Bromsgrove	947	764	9	..	19	100	20	35	5·8	820	786
Droitwich	500	436	2	..	3	25	3	31	6·8	471	431
Dudley	5,793	4,377	51	..	57	755	134	419	9·5	4,554	4,577
Evesham	508	357	2	..	98	31	3	17	3·9	424	343
Kidderminster . ..	992	823	5	..	24	111	8	21	2·9	918	866
King's Norton	5,236	3,355	50	..	52	564	41	1,174	23·2	3,581	3,955
Martley	445	328	3	..	5	44	14	51	14·6	295	323
Pershore	314	262	1	..	17	22	2	10	3·8	295	294
Shipston-on-Stour ..	391	280	7	..	48	35	2	19	5·4	280	289
Stourbridge	3,199	2,683	30	..	29	358	31	68	3·1	2,716	2,653
Tenbury	151	129	2	..	..	16	2	2	2·6	175	149
Upton-on-Severn ..	478	401	1	..	14	39	11	12	4·8	436	414
Worcester	1,261	843	8	..	21	176	86	127	16·9	843	839
	20,215	15,038	171	..	387	2,276	357	1,986	11·6	15,808	15,919
YORK, EAST RIDING.											
Beverley	664	541	4	..	14	64	2	39	6·2	633	567
Bridlington	533	416	6	..	19	50	..	42	7·9	323	456
Driffield	447	380	5	..	7	36	6	13	4·3	441	426
Howden	345	299	3	..	2	31	2	8	2.9	345	326
Kingston-upon-Hull ..	2,750	1,691	12	1	21	293	53	679	26·6	1,691	1,458
Patrington	180	163	1	..	2	12	..	2	1·1	204	147
Pocklington	362	311	..	..	4	27	4	16	5·5	370	323
Sculcoates..	5,585	4,409	30	1	43	698	35	369	7·2	8,553	4,837
Skirlaugh	233	195	..	..	2	28	2	6	3·4	224	183
York	2,560	2,054	24	..	28	252	39	163	7·9	2,261	2,011
	13,659	10,459	85	2	142	1,491	143	1,337	10·8	15,045	10,734

APP. A, No. 1.

Digest of Vaccination Officers' Returns, 1899.

—	Returns, 1899.									Total number of Certificates of successful Primary Vaccination at ALL AGES received during each of the calendar years 1899 and 1900.	
	Births.	Successfully Vaccinated.	Insusceptible of Vaccination.	Had Small-pox.	Number in respect of whom Certificates of conscientious objection have been received.	Died unvaccinated.	Vaccination postponed.	Remaining.	Children not finally accounted for (including cases postponed), per cent. of births.	1899.	1900.
YORK, NORTH RIDING.											
Aysgarth	100	84	..	..	4	8	2	2	4·0	84	91
Bedale	210	177	..	..	7	16	..	10	4·8	177	168
Easingwold	222	171	..	..	1	20	1	29	13·5	206	167
Guisborough	1,301	1,085	10	..	50	145	22	49	5·2	1,045	1,091
Helmsley	131	105	3	..	4	10	1	8	6·9	117	85
Kirkby Moorside ..	120	107	2	..	2	5	1	3	3·3	107	99
Leyburn	147	129	..	..	1	11	1	5	4·1	148	127
Malton	523	417	3	..	20	54	9	20	5·5	769	491
Middlesbrough	4,862	3,552	32	..	26	723	142	387	10·9	3,655	3,760
Northallerton	302	239	..	..	14	34	2	13	5·0	267	255
Pickering	260	210	1	..	6	25	7	11	6·9	246	253
Reeth	44	42	..	..	1	1	..	..	0·0	57	55
Richmond..	324	274	1	..	2	32	6	9	4·6	290	283
Scarborough	1,293	596	2	..	233	180	40	242	21·8	670	604
Stokesley	274	227	..	..	11	30	2	4	2·2	209	203
Thirsk	312	251	2	..	6	31	6	16	7·1	242	307
Whitby	531	429	8	..	19	54	8	13	4·0	530	409
	11,016	8,095	64	..	407	1,379	250	821	9·7	8,819	8,448
YORK, WEST RIDING.											
Barnsley	4,245	3,388	47	..	35	518	45	212	6·1	3,750	3,305
Bierley, North	3,259	2,144	27	..	66	414	65	543	18·7	2,940	2,863
Bradford	5,508	3,200	11	..	158	770	171	1,198	24·9	3,122	4,205
Bramley	2,361	1,870	31	..	51	283	20	106	5·3	1,933	1,911
Dewsbury	4,436	1,866	15	..	377	634	71	1,473	34·8	1,866	1,170
Doncaster..	2,685	1,957	39	..	174	360	43	112	5·8	2,746	2,118
Ecclesall Bierlow ..	5,277	4,178	101	..	51	617	39	291	6·3	4,195	4,306
Goole	862	695	8	..	3	111	4	41	5·2	908	748
Halifax	4,485	1,010	21	..	21	601	8	2,824	63·1	1,415	1,254
Hemsworth	773	587	2	..	10	97	16	61	10·0	675	769
Holbeck	1,136	840	19	..	13	169	26	69	8·4	1,064	918
Huddersfield	4,046	3,269	74	..	150	373	22	158	4·4	3,352	3,521
Hunslet	2,734	2,093	15	..	53	377	71	125	7·2	2,332	2,172
Keighley	1,959	412	7	..	850	204	..	486	24·8	457	481
Knaresborough	967	614	7	..	56	101	66	113	18·7	730	705
Leeds	7,387	5,350	76	..	116	869	208	768	13·2	5,629	5,536
Ouseburn, Great ..	248	222	1	..	9	14	..	2	0·8	240	196
Pateley Bridge	234	183	1	..	3	15	4	28	13·7	214	270
Penistone	449	369	2	..	4	38	23	13	8·0	398	[illegible]
Pontefract	2,493	1,877	32	..	51	308	49	176	9·0	1,934	1,998
Ripon	387	326	..	..	7	41	1	12	3·4	466	298
Rotherham	3,983	3,314	28	..	38	439	16	148	4·1	3,676	3,486
Saddleworth	395	263	1	..	68	40	3	20	5·8	420	254
Sedbergh	85	77	..	..	1	6	1	..	1·2	85	76
Selby	481	393	..	..	10	66	1	11	2·5	379	456
Settle	356	274	..	..	28	27	10	17	7·6	305	335
Sheffield	8,052	6,317	118	..	84	1,062	52	419	5·8	7,055	6,664
Skipton	1,158	558	3	..	215	139	23	220	21·0	608	713
Tadcaster	943	821	7	..	12	75	8	20	3·0	819	807
Thorne	424	273	2	..	21	49	9	70	18·6	363	295
Wakefield	3,658	3,036	21	..	60	412	27	102	3·5	3,627	3,019
Wetherby	384	322	..	..	4	44	6	8	3·6	338	345
Wharfedale	1,250	983	11	..	53	133	25	145	12·6	934	1,233
Wortley	1,666	1,306	10	..	18	193	31	108	8·3	1,597	1,249
	78,856	54,387	737	..	2,870	9,599	1,164	10,099	14·3	60,572	58,065

	Returns 1899. Births.	Successfully Vaccinated.	Insusceptible of Vaccination.	Had Small-pox.	Number in respect of whom Certificates of conscientious objection have been received.	Died unvaccinated.	Vaccination postponed.	Remaining.	Children not finally accounted for (including cases postponed), per cent. of births.	Total number of Certificates of successful Primary Vaccination at ALL AGES received during each of the calendar years 1899 and 1900. 1899.	1900.
ANGLESEY.											
Anglesey	344	299	..	..	1	40	2	2	1·2	323	295
Holyhead	565	484	..	..	..	57	8	16	4·2	555	383
	909	783	..	..	1	97	10	18	3·1	878	678
BRECKNOCK.											
Brecknock	415	355	1	..	1	45	4	9	3·1	356	371
Builth	232	186	..	..	3	22	12	9	9·1	198	181
Crickhowell	624	407	..	..	6	74	1	136	22·0	407	711
Hay	225	176	..	..	13	26	5	5	4·4	221	195
	1,496	1,124	1	..	23	167	22	159	12·1	1,182	1,458
CARDIGAN.											
Aberayron	267	226	..	..	..	32	4	5	3·4	219	212
Aberystwith	479	403	..	..	12	45	11	8	4·0	530	398
Cardigan	316	271	..	..	6	28	3	8	3·5	465	380
Lampeter	218	180	..	..	..	34	..	4	1·8	195	163
Tregaron	195	164	1	..	..	27	1	2	1·5	164	162
	1,475	1,244	1	..	18	166	19	27	3·1	1,573	1,315
CARMARTHEN.											
Carmarthen	824	717	2	..	1	92	6	6	1·5	818	710
Llandilo Fawr	674	578	..	..	2	83	7	4	1·6	597	725
Llandovery	232	190	..	..	..	39	1	2	1·3	144	115
Llanelly	1,802	1,503	2	..	9	240	22	26	2·7	1,282	1,784
Newcastle-in-Emlyn ..	452	385	..	..	1	57	2	7	2·0	387	399
	3,984	3,373	4	..	13	511	38	45	2·1	3,228	3,733
CARNARVON.											
Bangor and Beaumaris	1,047	893	3	..	12	118	4	17	2·0	963	968
Carnarvon	1,217	1,033	..	..	1	144	18	21	3·2	1,130	1,452
Conway	813	649	..	..	4	100	5	55	7·4	588	747
Pwllheli	491	381	8	..	1	67	4	30	6·9	328	471
	3,568	2,956	11	..	18	429	31	123	4·3	3,009	3,638
DENBIGH.											
Llanrwst	335	262	..	..	..	47	10	16	7·8	279	302
Ruthin	265	233	..	..	..	28	3	1	1·5	243	234
Wrexham	2,303	1,958	16	..	6	243	26	54	3·5	2,366	2,099
	2,903	2,453	16	..	6	318	39	71	3·8	2,888	2,635

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	Returns 1899.									Total number of Certificates of successful Primary Vaccination at ALL AGES received during each of the calendar years 1899 and 1900.	
	Births.	Successfully Vaccinated.	Insusceptible of Vaccination.	Had Small-pox.	Number in respect of whom Certificates of conscientious objection have been received.	Died unvaccinated.	Vaccination postponed.	Remaining.	Children not finally accounted for (including cases postponed), per cent. of births.	1899.	1900.
FLINT.											
Asaph, St.	723	586	1	..	..	105	9	22	4·3	656	552
Hawarden	510	452	2	..	2	35	10	9	3·7	508	496
Holywell	1,189	1,012	..	..	..	112	28	37	5·5	984	1,121
	2,422	2,050	3	..	2	252	47	68	4·7	2,148	2,169
GLAMORGAN.											
Bridgend and Cowbridge	2,014	1,510	7	..	8	271	46	172	10·8	1,432	1,467
Cardiff	7,543	5,362	43	..	120	1,038	42	938	13·0	5,585	5,991
Gower	315	247	1	..	2	33	2	30	10·2	284	276
Merthyr Tydfil	4,510	3,239	6	..	29	783	155	298	10·0	3,205	3,956
Neath	2,356	1,883	13	..	18	270	80	92	7·3	1,760	1,912
Pontardawe	893	783	..	..	..	99	5	6	1·2	897	839
Pontypridd	7,070	4,656	12	..	30	1,328	106	938	14·8	4,401	5,728
Swansea	3,668	2,918	5	..	15	436	12	282	8·0	3,001	2,792
	28,369	20,598	87	..	222	4,258	448	2,756	11·3	20,565	22,961
MERIONETH.											
Bala	134	94	..	..	..	22	11	7	13·4	95	91
Corwen	434	378	..	..	4	34	3	15	4·1	384	346
Dolgelly	328	290	..	..	1	30	2	5	2·1	286	302
Festiniog	811	594	1	..	1	119	10	86	11·8	563	677
	1,707	1,356	1	..	6	205	26	113	8·1	1,328	1,416
MONTGOMERY.											
Forden	374	324	1	..	1	40	1	7	2·1	356	317
Llanfyllin	458	408	1	..	2	41	..	6	1·3	422	382
Machynlleth	261	219	..	..	..	31	6	5	4·2	205	243
Newtown and Llanidloes	556	435	3	..	1	54	9	54	11·3	502	437
	1,649	1,386	5	..	4	166	16	72	5·3	1,485	1,379
PEMBROKE.											
Haverfordwest	958	763	1	..	2	117	32	43	7·8	921	833
Narberth	399	367	..	..	..	25	1	6	1·8	372	329
Pembroke	838	700	3	..	4	77	16	38	6·4	704	841
	2,195	1,830	4	..	6	219	49	87	6·2	1,997	2,003
RADNOR.											
Knighton	303	238	..	..	11	21	4	29	10·9	315	238
Rhayader	280	133	..	..	2	17	..	128	45·7	146	103
	583	371	..	..	13	88	4	157	27·6	461	341

No. 2.

App. A, No. 2.

Digest of Vaccination Officers' Returns, 1900.

DIGEST of the VACCINATION OFFICERS' RETURNS with regard to Children whose Births were registered in the Year 1900.

The following is a summary of the twenty-ninth annual return under the Vaccination Act, 1871:—Of 927,222 births returned to the Board by the several vaccination officers in England and Wales as registered during the year 1900, the number which, at the time the return was made, had been registered as successfully vaccinated was 636,940 (being 68·7 per cent. of the whole), and the number registered as having died unvaccinated was 103,538 (or 11·2 per cent. of the whole). Of the remaining 186,744 children, 2,261 (or 0·2 per cent. of the whole) had been registered as insusceptible of vaccination; 2 as having contracted small-pox; 14,225 (or 1·5 per cent.) as having their vaccination postponed by medical certificate; and 39,699 (or 4·3 per cent.) in respect of whom certificates of conscientious objection were received; leaving 130,557 (or 14·1 per cent.) as "removed," "not to be traced," or otherwise unaccounted for. If from the 927,222 births returned by these officers deduction be first made of the deaths that took place before vaccination, it appears that, of the surviving 823,684 children, there were registered at the time of the return 77·3 per cent. as successfully vaccinated; 0·3 per cent. as either insusceptible of vaccination, or as having had small-pox; 1·7 per cent. as under medical certificate of postponement; and 4·8 per cent. in respect of whom certificates of conscientious objection to vaccination had been obtained; leaving 15·9 per cent. as at that time still unaccounted for as regards vaccination.

The proportion of cases unaccounted for in the metropolitan returns for 1900 is 25·8 per cent.; in the provincial returns, 13·9. Of the registered births of the twenty-nine years, 1872–1900, the proportion not finally accounted for in regard to vaccination

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Digest of Vaccination Officers' Returns, 1900.

(including cases postponed) in each year respectively has been as follows :—

—	Metropolis.	Rest of England.	—	Metropolis.	Rest of England.
1872	8·8	4·5	1887	9·0	6·7
1873	8·7	4·2	1888	10·3	8·2
1874	8·8	4·1	1889	11·6	9·6
1875	9·3	3·8	1890	13·9	10·9
1876	6·5	4·0	1891	16·4	12·9
1877	7·1	4·1	1892	18·4	14·3
1878	7·1	4·3	1893	18·2	15·7
1879	7·8	4·5	1894	20·6	19·0
1880	7·0	4·5	1895	24·9	19·8
1881	5·7	4·3	1896	26·4	22·3
1882	6·6	4·5	1897	29·1	21·6
1883	6·5	4·9	1898	33·0	19·6
1884	6·8	5·3	1899	27·7	15·4
1885	7·0	5·5	1900	25·8	13·9
1886	7·8	6·1			

In 1900 the proportion of cases unaccounted for (excluding the postponed cases) in the Metropolis and in the rest of England, was 24·5 and 12·4 per cent. respectively.

The numbers of certificates of successful primary vaccination at all ages received during the calendar years 1900 and 1901, and recorded in the last two columns in the tables following, are taken from a return, No. 384, made to the House of Commons on 1st December, 1902.

Returns, 1900.

—	Births.	Successfully Vaccinated.	Insusceptible of Vaccination.	Had Small-pox.	Number in respect of whom Certificates of conscientious objection have been received.	Died unvaccinated.	Vaccination postponed.	Remaining.	Children not finally accounted for (including cases postponed), per cent. of Births.		Total number of Certificates of Successful Primary Vaccination at ALL AGES received during each of the calendar years 1900 and 1901.	
									1900.	1899.	1900.	1901.
ENGLAND AND WALES	927,222	636,940	2,261	2	39,699	103,538	14,225	130,557	15·6	17·2	676,807	710,785
DIVISIONS.												
London	131,647	81,286	289	1	1,368	14,756	1.690	32,257	25·8	27·7	86,591	111,958
South Eastern	79,441	60,289	182	—	3,587	7,116	1,144	7,123	10·4	13·4	62,814	69,526
South Midland	56,915	35,279	115	—	4,888	5,301	628	10,704	19·9	21·2	37,881	42,507
Eastern	52,768	34,867	94	—	3,457	5,435	818	8,097	16·9	17·4	37,498	39,377
South Western	45,487	33,139	66	—	3,119	3,932	1,077	4,154	11·4	14·2	36,774	35,830
West Midland	109,896	75,059	299	—	3,654	13,009	1,888	15,987	16·3	17·7	78,864	80,516
North Midland	59,278	30,070	78	—	6,665	7,392	1,401	13,672	25·4	28·4	33,676	33,850
North Western	155,685	114,412	448	—	5,496	19,080	1,885	14,364	10·4	11·7	123,039	116,165
York	108,733	73,828	437	—	4,148	12,266	1,222	11,832	12·6	13·3	77,247	76,294
Northern	69,851	49,359	188	1	2,360	8,486	1,419	8,038	13·5	14·3	51,046	53,904
Wales	62,521	49,352	65	—	957	6,765	1,053	4,329	8·6	9·3	51,377	50,858

App. A, No. 2.
Digest of Vaccination Officers' Returns, 1900.

—	Returns, 1900. Births.	Successfully Vaccinated.	Insusceptible of Vaccination.	Had Small-pox.	Number in respect of whom Certificates of conscientious objection have been received.	Died unvaccinated.	Vaccination postponed.	Remaining.	Children not finally accounted for (including cases postponed), per cent. of Births.	Total number of Certificates of successful Primary Vaccination at ALL AGES received during each of the calendar years 1900 and 1901. 1900.	1901.
II.—South Eastern.											
Surrey (extra-metropolitan).	16,835	12,341	54	—	524	1,482	295	2,139	14·5	12,246	16,836
Kent (extra-metropolitan)	23,562	18,464	58	—	1,073	2,188	243	1,536	7·6	19,840	20,349
Sussex	13,429	9,419	19	—	1,262	1,154	276	1,299	11·7	10,018	10,600
Hampshire	18,949	15,692	45	—	471	1.673	240	828	5·6	16,313	16,416
Berkshire	6,666	4,373	6	—	357	619	90	1,321	21·2	4,397	5,325
	79,441	60,289	182	—	3,687	7.116	1,144	7,123	10·4	62,814	69,526
III.—South Midland.											
Middlesex (extra-metropolitan).	21,090	14,404	71	—	373	2,117	284	3,841	19·6	14,969	19,512
Hertfordshire	7,041	5,249	13	—	486	582	75	636	10·1	5,585	5,882
Buckinghamshire.. ..	4,359	2,832	2	—	811	349	37	328	8·4	3,029	3,179
Oxfordshire..	4,403	3,263	6	—	526	320	25	263	6·5	4,055	3,479
Northamptonshire ..	9,492	3,248	4	—	1,506	956	126	3,652	39·8	3,510	3,454
Huntingdonshire	1,159	954	—	—	59	110	5	31	3·1	979	1,037
Bedfordshire	4,369	1,313	9	—	883	443	10	1,711	39·4	1,456	1,579
Cambridgeshire	5,002	4,016	10	—	244	424	66	242	6·2	4,298	4,385
	56,915	35,279	115	—	4,888	5,301	628	10,704	19·9	37,881	42,507
IV.—Eastern.											
Essex	31,159	19,452	78	—	1,056	3,305	619	6,649	23·3	20,775	22,877
Suffolk	9,340	7,063	10	—	565	834	118	730	9·1	7,562	7,566
Norfolk	12,269	8,332	6	—	1,836	1,296	81	718	6·5	9,161	8,934
	52,768	34,867	94	—	3,457	5,435	818	8,097	16·9	37,498	39,377

APP. A, No. 2.

Digest of Vaccination Officers' Returns, 1900.

—	Returns, 1900. Births.	Successfully Vaccinated.	Insusceptible of Vaccination.	Had Small-pox.	Number in respect of whom Certificates of conscientious objection have been received.	Died unvaccinated.	Vaccination postponed.	Remaining.	Children not finally accounted for (including cases postponed), per cent of Births.	Total number of Certificates of successful Primary Vaccination at ALL AGES received during each of the calendar years 1900 and 1901. 1900.	1901.
V.—SOUTH WESTERN.											
Wiltshire	6,553	3,759	6	—	1,328	443	140	877	15·5	4,143	4,132
Dorsetshire	4,524	3,553	6	—	213	323	92	337	9·5	3,932	3,933
Devonshire	15,658	12,436	25	—	351	1,479	374	993	8·7	13,413	12,835
Cornwall	7,709	5,885	8	—	250	763	186	617	10·4	7,333	6,986
Somersetshire	11,043	7,506	21	—	977	924	285	1,330	14·6	7,953	7,944
	45,487	33,139	66	—	3,119	3,932	1,077	4,154	11·4	36,774	35,830
VI.—WEST MIDLAND.											
Gloucestershire	16,720	9,274	27	—	1,565	1,624	444	3,786	25·3	10,206	10,162
Herefordshire	2,622	2,178	2	—	89	216	33	104	5·2	2,441	2,377
Shropshire	6,663	5,706	11	—	128	587	50	181	3·5	6,006	6,100
Staffordshire	36,379	23,898	98	—	722	4,700	747	6,214	19·1	24,655	25,678
Worcestershire	19,840	15,228	63	—	448	2,142	334	1,625	9·9	15,919	16,295
Warwickshire	27,672	18,775	98	—	702	3,740	280	4,077	15·7	19,637	19,904
	109,896	75,059	299	—	3,654	13,009	1,888	15,987	16·3	78,864	80,516
VII.—NORTH MIDLAND.											
Leicestershire	12,831	2,833	3	—	2,808	1,713	397	5,077	42·7	3,478	3,265
Rutlandshire	456	390	2	—	29	27	—	8	1·8	429	381
Lincolnshire	13,158	8,862	21	—	1,682	1,396	249	948	9·1	9,939	9,925
Nottinghamshire	18,195	10,526	42	—	1,630	2,447	438	3,112	19·5	11,927	12,252
Derbyshire	14,638	7,459	10	—	516	1,809	317	4,527	33·1	7,903	8,027
	59,278	30,070	78	—	6,685	7,392	1,401	13,672	25·4	33,676	33,850
VIII.—NORTH WESTERN.											
Cheshire	21,645	18,031	68	—	249	2,311	308	678	4·6	18,886	17,962
Lancashire	134,040	96,381	380	—	5,247	16,769	1,577	13,686	11·4	104,153	98,203
	155,685	114,412	448	—	5,496	19,080	1,885	14,364	10·4	123,039	116,165

—	Returns, 1900.									Total number of Certificates of successful Primary Vaccination at ALL AGES received during each of the calendar year 1900 and 1901.	
	Births.	Successfully Vaccinated.	Insusceptible of Vaccination.	Had Small-pox.	Number in respect of whom Certificates of conscientious objection have been received.	Died unvaccinated.	Vaccination postponed.	Remaining.	Children not finally accounted for (including cases postponed), per cent. of Births.	1900.	1901.
IX.—York.											
West Riding..	78,965	55,616	345	—	3,428	9,167	871	9,543	13·2	58,065	57,380
East Riding (with York)	13,463	10,089	60	—	196	1,705	118	1,295	10·5	10,734	10,791
North Riding	11,305	8,123	32	—	529	1,394	233	994	10·9	8,448	8,123
	103,733	73,828	437	—	4,148	12,266	1,222	11,832	12·6	77,247	76,294
X.—Northern.											
Durham	41,669	29,204	117	—	1,285	5,300	1,031	4,732	13·8	29,902	32,146
Northumberland	19,278	13,390	68	—	614	2,313	293	2,600	15·0	14,088	14,559
Cumberland	7,451	5,518	1	1	408	760	81	682	10·2	5,708	5,923
Westmorland	1,453	1,247	2	—	53	113	14	24	2·6	1,348	1,276
	69,851	49,359	188	1	2,360	8,486	1,419	8,038	13·5	51,046	53,904
XI.—Welsh.											
Monmouthshire	10,463	7,443	11	—	606	1,195	294	914	11·5	7,661	8,144
South Wales .. .. / North Wales	52,058	41,909	54	—	351	5,570	759	3,415	8·0	43,716	42,714
	62,521	49,352	65	—	957	6,765	1,053	4,329	8·6	51,377	50,858

—	Returns, 1900.									Total number of Certificates of successful Primary Vaccination at ALL AGES received during each of the calendar years 1900 and 1901.	
	Births.	Successfully Vaccinated.	Insusceptible of Vaccination.	Had Small-pox.	Number in respect of whom Certificates of conscientious objection have been received.	Died unvaccinated.	Vaccination postponed.	Remaining.	Children not finally accounted for (including cases postponed), per cent. of Births.	1900.	1901.
ENGLAND AND WALES.	927,222	636,940	2,261	2	39,699	103,588	14,226	130,557	15·6	676,807	710,786
Ditto (excluding Metropolitan Unions).	795,575	555,654	1,972	1	38,331	88,782	12,536	98,300	13·9	590,216	598,827
METROPOLITAN UNIONS.	131,647	81,286	289	1	1,368	14,756	1,690	32,257	25·8	86,591	111,958
COUNTIES.											
ENGLAND:											
Bedford	4,369	1,313	9	—	883	443	10	1,711	39·4	1,456	1,579
Berks	6,666	4,373	6	—	257	619	90	1,321	21·2	4,397	5,326
Buckingham ..	4,359	2,832	2	—	811	349	37	328	8·4	3,029	3,179
Cambridge ..	5,002	4,016	10	—	244	424	60	242	6·2	4,298	4,385
Chester	21,645	18,031	68	—	249	2,311	308	678	4·6	18,886	17,962
Cornwall ..	7,709	5,885	8	—	250	763	186	617	10·4	7,333	6,986
Cumberland ..	7,451	5,518	1	1	408	760	81	682	10·2	5,708	5,923
Derby	14,638	7,459	10	—	516	1,809	317	4,527	33·1	7,903	8,027
Devon	15,658	12,436	26	—	351	1,479	374	993	8·7	13,413	12,836
Dorset	4,524	3,553	6	—	213	323	92	337	9·5	3,932	3,933
Durham ..	41,669	29,204	117	—	1,285	5,300	1,031	4,732	13·8	29,902	32,146
Essex	31,159	19,452	78	—	1,056	3,305	619	6,649	23·3	20,775	22,877
Gloucester ..	16,720	9,274	27	—	1,565	1,624	444	3,786	25·3	10,206	10,162
Hereford ..	2,622	2,178	2	—	89	216	33	104	5·2	2,441	2,377
Hertford ..	7,041	5,249	13	—	486	582	75	636	10·1	5,585	5,882
Huntingdon ..	1,159	954	—	—	59	110	5	31	3·1	979	1,037
Kent (extra-metropolitan).	23,562	18,464	58	—	1,073	2,188	243	1,536	7·6	19,840	20,349
Lancaster ..	134,040	96,381	380	—	5,247	16,769	1,577	13,686	11·4	104,153	98,208
Leicester ..	12,831	2,833	3	—	2,808	1,713	397	5,077	42·7	3,478	3,265
Lincoln	13,158	8,962	21	—	1,682	1,396	249	948	9·1	9,939	9,925
Middlesex (ex-metropolitan).	21,090	14,404	71	—	373	2,117	284	3,841	19·6	14,969	19,512
Monmouth ..	10,463	7,443	11	—	606	1,195	294	914	11·5	7,661	8,144
Norfolk	12,269	8,332	6	—	1,836	1,296	81	718	6·5	9,161	8,934
Northampton ..	9,492	3,248	4	—	1,506	956	126	3,652	39·8	3,510	3,454
Northumberland	19,278	13,390	68	—	614	2,313	298	2,600	15·0	14,088	14,559

APP. A, No. 2.

Digest of Vaccination Officers' Returns, 1900.

—	Returns, 1900.									Total number of Certificates of successful Primary Vaccination at ALL AGES received during each of the calendar years 1900 and 1901.	
	Births.	Successfully Vaccinated.	Insusceptible of Vaccination.	Had Small-pox.	Number in respect of whom Certificates of conscientious objection have been received.	Died unvaccinated.	Vaccination postponed.	Remaining.	Children not finally accounted for (including cases postponed), per cent. of Births.	1900.	1901.
COUNTIES—*cont.*											
ENGLAND—*cont.*											
Nottingham ..	18,195	10,526	42	—	1,630	2,447	438	3,112	19·5	11,927	12,252
Oxford	4,403	3,263	6	—	526	320	25	263	6·5	4,055	3,479
Rutland ..	456	390	2	—	29	27	—	8	1·8	429	381
Salop	6,663	5,706	11	—	128	587	50	181	3·5	6,006	6,100
Somerset ..	11,043	7,506	21	—	977	924	285	1,330	14·6	7,953	7,944
Southampton ..	18,949	15,692	45	—	471	1,673	240	828	5·6	16,313	16,416
Stafford	36,379	23,898	98	—	722	4,700	747	6,214	19·1	24,655	25,678
Suffolk	9,340	7,083	10	—	565	834	118	730	9·1	7,562	7,566
Surrey (extra-metropolitan).	16,835	12,341	54	—	524	1,482	295	2,139	14·5	12,246	16,836
Sussex	13,429	9,419	19	—	1,262	1,154	276	1,299	11·7	10,018	10,600
Warwick ..	27,672	18,775	98	—	702	3,740	280	4,077	15·7	19,637	19,904
Westmorland ..	1,453	1,247	2	—	53	113	14	24	2·6	1,348	1,276
Wilts	6,553	3,759	6	—	1,328	443	140	877	15·5	4,143	4,132
Worcester ..	19,840	15,228	63	—	448	2,142	334	1,625	9·9	15,919	16,296
York, E. Riding	13,463	10,089	60	—	196	1,705	118	1,295	10·5	10,734	10,791
York, N. Riding	11,306	8,123	32	—	529	1,394	233	994	10·9	8,448	8,123
York, W. Riding	78,965	55,616	345	—	3,423	9,167	871	9,543	13·2	58,065	57,380
WALES:											
Anglesey ..	853	736	1	—	—	86	9	21	3·5	678	747
Brecknock ..	1,504	1,287	—	—	23	118	19	57	5·1	1,458	1,185
Cardigan ..	1,362	1,159	—	—	14	137	15	37	3·8	1,315	1,217
Carmarthen ..	4,006	3,524	—	—	8	392	44	38	2·0	3,733	3,237
Carnarvon ..	3,449	2,973	2	—	14	388	20	52	2·1	3,628	3,072
Denbigh ..	3,107	2,660	3	—	8	335	29	72	3·3	2,635	2,505
Flint	2,455	2,112	5	—	3	239	36	60	3·9	2,169	2,073
Glamorgan ..	29,377	22,684	40	—	252	3,289	501	2,611	10·6	22,961	23,880
Merioneth ..	1,683	1,299	1	—	4	177	30	172	12·0	1,416	1,319
Montgomery ..	1,619	1,375	—	—	9	157	23	55	4·8	1,379	1,369
Pembroke ..	2,080	1,783	1	—	2	194	25	75	4·8	2,003	1,900
Radnor	563	317	1	—	14	58	8	165	30·7	341	210

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Digest of Vaccination Officers' Returns, 1900.

METROPOLITAN UNIONS.	RETURNS, 1900. Births.	Successfully Vaccinated.	Insusceptible of Vaccination.	Had Small-pox.	Number in respect of whom Certificates of conscientious objection have been received.	Died unvaccinated.	Vaccination postponed.	Remaining.	Children not finally accounted for (including cases postponed), per cent. of births.	Total number of Certificates of successful Primary Vaccination at ALL AGES received during each of the calendar years 1900 and 1901. 1900.	1901.
Bethnal Green	4,625	1,767	3	—	19	577	12	2,247	48·8	2,081	2,053
Camberwell	7,251	4,730	9	—	75	830	72	1,526	22·0	4,619	6,636
Chelsea	2,254	1,669	3	—	29	221	17	315	14·7	1,845	1,833
Fulham	4,552	3,446	13	—	63	470	65	496	12·3	3,754	3,588
George, St., Hanover Square.	2,361	1,942	18	—	29	232	17	123	5·9	1,984	2,188
George, St., in the East	2,178	1,276	1	—	—	172	—	729	33·5	1,498	1,944
Giles, St., and St. George	1,025	605	1	—	2	75	1	341	33·4	631	974
Greenwich	5,590	4,196	19	—	68	601	95	611	12·6	4,393	4,919
Hackney	7,200	3,370	11	—	72	911	61	2,775	39·4	4,371	7,194
Hammersmith	3,007	2,420	2	—	36	310	19	220	7·9	2,509	2,682
Hampstead	1,623	1,323	13	—	37	108	11	131	8·7	1,355	1,402
Holborn	4,557	2,765	5	—	26	491	104	1,166	27·9	2,568	6,030
Islington	9,316	5,960	31	—	124	859	175	2,147	24·9	6,152	8,997
Kensington	3,594	2,884	4	—	40	375	14	277	8·1	3,068	3,463
Lambeth	9,202	6,266	11	—	112	1,027	58	1,728	19·4	6,375	7,735
Lewisham..	3,323	2,283	13	—	73	338	15	601	18·5	2,310	2,765
London, City of	403	291	3	—	8	52	6	43	12·2	326	381
Marylebone	4,008	2,899	6	—	16	395	98	594	17·3	3,189	4,133
Mile End Old Town ..	4,308	896	1	—	13	481	—	2,917	67·7	1,004	1,754
Olave, St.	4,459	2,889	9	—	23	587	—	951	21·3	3,375	5,688
Paddington	2,903	2,196	8	—	31	309	39	320	12·4	2,224	2,745
Pancras, St.	6,474	3,636	11	—	67	697	170	1,893	31·9	3,682	5,785
Poplar	5,967	2,153	2	1	28	890	21	2,872	48·5	2,479	2,802
Shoreditch	4,015	1,285	6	—	9	594	135	1,986	52·8	1,479	1,553
Southwark	7,012	4,084	16	—	72	973	15	1,852	26·6	4,106	4,553
Stepney	1,852	761	2	—	4	262	—	823	44·4	789	1,281
Strand	354	251	—	—	3	35	6	59	18·4	266	519
Wandsworth and Clapham.	10,986	7,201	42	—	185	1,215	416	1,927	21·3	8,074	8,500
Westminster	665	528	1	—	8	55	3	70	11·0	546	1,494
Whitechapel	2,920	2,279	3	—	9	264	17	358	12·8	2,433	2,633
Woolwich	3,663	3,016	22	—	87	351	28	159	5·1	3,167	3,735
	131,647	81,286	289	1	1,368	14,756	1,690	32,257	25·8	86 591	111,958

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Digest of Vaccination Officers' Returns, 1900.

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	Births	Successfully Vaccinated.	Insusceptible of Vaccination.	Had Small-pox.	Number in respect of whom Certificates of conscientious objection have been received.	Died unvaccinated.	Vaccination postponed.	Remaining.	Children not finally accounted for (including cases postponed), per cent. of births.	1900.	1901.
BEDFORD.											
Ampthill	521	302	1	—	113	47	2	56	11·1	316	305
Bedford	1,295	226	3	—	14	132	—	920	71·0	253	240
Biggleswade	740	494	3	—	167	47	1	28	3·9	505	475
Leighton Buzzard ..	414	188	2	—	155	39	3	27	7·2	262	284
Luton	1,399	103	—	—	434	178	4	680	48·9	120	275
	4,369	1,313	9	—	883	443	10	1,711	39·4	1,456	1,579
BERKS.											
Abingdon	401	335	—	—	11	33	3	19	5·5	352	339
Bradfield	414	331	1	—	22	28	6	26	7·7	360	294
Easthampstead	332	288	—	—	6	26	4	8	3·6	314	306
Faringdon..	334	256	1	—	18	30	13	16	8·7	258	250
Hungerford and Ramsbury.	352	313	—	—	11	24	2	2	1·1	315	379
Maidenhead	564	410	—	—	77	42	6	29	6·2	417	448
Newbury	433	362	—	—	24	32	4	11	3·5	383	399
Reading	1,886	466	—	—	29	263	10	1,118	59·8	387	877
Wallingford	291	259	—	—	7	16	6	3	3·1	289	263
Wantage	373	314	—	—	9	27	13	10	6·2	302	343
Windsor	877	711	3	—	24	63	18	58	8·7	688	741
Wokingham	409	328	1	—	19	35	5	21	6·4	332	686
	6,666	4,373	6	—	257	619	90	1,321	21·2	4,397	5,325
BUCKINGHAM.											
Amersham	515	290	—	—	124	41	—	60	11·7	292	371
Aylesbury..	554	426	—	—	74	38	5	11	2·9	449	444
Buckingham	260	175	—	—	62	15	—	8	3·1	172	211
Eton..	862	691	1	—	23	76	26	45	8·2	728	703
Newport Pagnell ..	701	455	—	—	159	61	5	21	3·7	502	492
Winslow	166	88	1	—	59	15	1	2	1·8	136	99
Wycombe	1,301	707	—	—	310	103	—	181	13·9	750	860
	4,359	2,832	2	—	811	349	37	328	8·4	3,029	3,179
CAMBRIDGE.											
Cambridge	923	708	7	—	28	79	3	98	10·9	769	839
Caxton and Arrington	180	152	1	—	15	8	1	3	2·2	150	178
Chesterton	783	636	—	—	21	53	6	17	2·9	773	709
Ely	494	401	1	—	46	35	4	7	2·2	509	442
Linton	234	200	—	—	3	11	3	17	8·5	224	217
Newmarket	848	673	—	—	23	83	39	30	8·1	673	713
North Witchford ..	445	345	1	—	47	43	—	9	2·0	361	318
Whittlesey	204	149	—	—	31	17	—	7	3·4	177	177
Wisbech	891	702	—	—	30	95	10	54	7·2	663	792
	5,002	4,016	10	—	244	424	66	242	6·2	4,298	4,385

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—	Returns, 1900. Births.	Successfully Vaccinated.	Insusceptible of Vaccination.	Had Small-pox.	Number in respect of whom Certificates of conscientious objection have been received.	Died unvaccinated.	Vaccination postponed.	Remaining.	Children not finally accounted for (including cases postponed), per cent. of births.	Total number of Certificates of successful Primary Vaccination at ALL AGES received during each of the calendar years 1900 and 1901. 1900.	1901.
CHESTER.											
Birkenhead	4,997	4,257	12	—	10	538	48	132	3·6	4,211	4,111
Bucklow	1,893	1,621	14	—	22	189	12	35	2·5	1,800	1,622
Chester	1,477	1,223	1	—	4	174	34	41	5·1	1,334	1,219
Congleton	880	725	1	—	12	74	30	38	7·7	961	808
Macclesfield	1,440	1,236	—	—	14	148	20	22	2·9	1,310	1,156
Nantwich	2,225	1,765	9	—	67	204	45	135	8·1	1,985	1,812
Northwich	1,736	1,549	5	—	12	149	7	14	1·2	1,563	1,478
Runcorn	1,179	1,011	3	—	10	121	19	15	2·9	1,066	1,021
Stockport	4,223	3,253	22	—	91	578	72	207	6·6	3,225	3,307
Tarvin	407	370	—	—	4	30	—	3	0·7	368	344
Wirral	1,188	1,021	1	—	3	106	21	36	4·8	1,063	1,064
	21,645	18,031	68	—	249	2,311	308	678	4·6	18,886	17,962
CORNWALL.											
Austell, St.	871	723	1	—	26	73	13	35	5·5	816	843
Bodmin	426	358	—	—	6	31	4	27	7·3	407	378
Camelford	180	147	—	—	7	18	1	7	4·4	147	149
Columb Major, St. ..	379	311	1	—	9	23	26	9	9·2	380	310
Falmouth	538	389	—	—	40	60	18	31	9·1	1,327	817
Germans, St.	483	423	—	—	1	42	10	7	3·5	444	389
Helston	521	397	1	—	4	65	13	41	10·4	405	450
Launceston	296	244	—	—	20	18	2	5	2·3	284	251
Liskeard	556	450	—	—	40	39	8	19	4·9	448	492
Penzance	1,197	938	3	—	30	126	24	76	8·4	999	940
Redruth	1,286	761	1	—	22	181	31	290	25·0	796	925
Stratton	157	113	1	—	—	18	2	23	15·9	129	107
Truro	817	631	—	—	36	69	34	47	9·9	749	935
	7,709	5,885	8	—	250	763	186	617	10·4	7,333	6,966
CUMBERLAND,											
Alston-with-Garrigill..	57	39	—	—	10	4	—	4	7·0	40	38
Bootle	440	366	—	—	2	49	16	7	5·2	469	445
Brampton	162	115	—	—	2	29	7	9	9·9	184	197
Carlisle	1,764	1,498	—	—	17	199	17	33	2·8	1,592	1,431
Cockermouth	2,063	979	—	1	264	232	26	561	28·5	934	1,318
Longtown	152	130	—	—	2	11	—	9	5·9	120	138
Penrith	528	451	—	—	29	43	3	2	0·9	459	436
Whitehaven	1,764	1,505	1	—	56	143	9	50	3·3	1,427	1,498
Wigton	521	435	—	—	26	50	3	7	1·9	483	422
	7,451	5,518	1	1	408	760	81	682	10·2	5,708	5,923
DERBY.											
Ashbourne	519	391	—	—	17	42	13	56	13·3	500	363
Bakewell	841	616	2	—	70	66	16	71	10·3	648	587
Belper	2,067	1,269	2	—	77	207	53	459	24·8	1,404	1,273
Chapel-en-le-Frith ..	713	611	2	—	5	56	8	31	5·5	658	601
Chesterfield	4,673	2,620	2	—	81	682	119	1,168	27·5	2,607	2,821
Derby	2,935	406	—	—	59	434	1	2,035	69·4	432	796
Glossop	635	365	—	—	127	55	33	55	13·9	364	323
Hayfield	338	259	—	—	4	37	3	35	11·2	295	238
Shardlow	1,918	922	2	—	76	230	71	617	35·9	995	1,025
	14,638	7,459	10	—	516	1,809	317	4,527	33·1	7,908	8,027

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DEVON.											
Axminster	326	286	2	—	11	16	3	8	3·4	290	311
Barnstaple	978	770	1	—	69	80	18	40	5·9	882	783
Bideford	543	447	—	—	37	38	10	11	3·9	448	414
Crediton	348	314	—	—	6	23	—	5	1·4	326	329
Devonport	1,935	1,350	8	—	6	250	51	270	16·6	1,503	1,517
East Stonehouse	439	353	1	—	3	53	7	22	6·6	353	346
Exeter	831	640	—	—	30	93	7	61	8·2	716	686
Holsworthy	231	198	1	—	2	22	3	5	3·5	202	181
Honiton	412	371	1	—	6	26	—	8	1·9	396	400
Kingsbridge	339	306	—	—	9	15	1	8	2·7	321	346
Newton Abbot	1,555	1,278	3	—	52	139	41	42	5·3	1,335	1,287
Okehampton	358	314	—	—	4	16	21	3	6·7	322	329
Plymouth	2,870	1,940	6	—	23	378	134	389	18·2	2,263	2,025
Plympton St. Mary	494	446	—	—	—	30	1	17	3·6	435	428
South Molton	3 8	256	—	—	3	32	5	22	8·5	255	223
Tavistock	601	514	—	—	31	46	—	13	2·2	516	510
Thomas, St.	1,194	1,015	—	—	31	74	45	29	6·2	1,038	1,007
Tiverton	645	540	1	—	14	53	17	20	5·7	570	548
Torrington	298	255	—	—	5	28	4	6	3·4	275	286
Totnes	910	842	1	—	9	67	6	14	2·1	868	846
	15,6 8	12,430	25	—	351	1,479	374	993	8·7	13,413	12,835
DORSET.											
Beaminster	214	189	—	—	1	17	1	6	3·3	222	166
Blandford	256	194	—	—	17	22	7	16	9·0	183	178
Bridport	258	233	—	—	4	16	2	3	1·9	254	249
Cerne	127	109	—	—	7	5	2	4	4·7	115	85
Dorchester	402	318	—	—	5	33	5	41	11·4	287	417
Poole	873	631	5	—	61	79	40	54	10·8	876	740
Shaftesbury	277	234	1	—	13	12	4	13	6·1	230	218
Sherborne	261	223	—	—	1	14	5	16	8·0	231	213
Sturminster	194	176	—	—	5	7	1	5	3·1	189	178
Wareham and Purbeck	360	325	—	—	13	17	2	3	1·4	347	377
Weymouth	941	587	—	—	81	84	21	168	20·1	653	710
Wimborne and Cranborne.	358	326	—	—	5	17	2	8	2·8	342	374
	4,524	3,553	6	—	213	323	92	337	9·5	3,932	3,933
DURHAM.											
Auckland	3,211	2,187	9	—	243	435	11	326	10·5	2,225	2,294
Chester-le-Street	2,361	1,777	11	—	31	359	36	147	7·8	1,796	1,932
Darlington	1,560	1,008	2	—	39	203	89	219	19·7	1,134	1,068
Durham	2,261	1,704	9	—	97	306	49	96	6·4	1,690	2,375
Easington	1,852	1,591	1	—	10	205	14	31	2·4	1,636	1,728
Gateshead	6,3 0	3,052	8	—	465	790	93	1,942	32·0	2,892	3,485
Hartlepool	3,066	2,384	14	—	46	346	138	138	9·0	2,422	2,512
Houghton-le-Spring	1,555	1,282	3	—	—	181	14	75	5·7	1,325	1,353
Lanchester	2,953	2,030	12	—	180	382	105	243	11·8	2,189	2,267
Sedgefield	746	624	1	—	13	85	7	16	3·1	614	760
South Shields	5,915	4,350	19	—	34	715	144	747	15·1	4,211	4,752
Stockton	2,224	1,755	9	—	44	287	35	94	5·8	1,900	1,892
Sunderland	6,651	4,770	18	—	49	909	280	625	13·6	4,923	4,938
Teesdale	504	413	—	—	12	44	11	21	6·9	601	445
Weardale	460	371	—	—	22	53	5	9	3·0	344	345
	41,669	29,204	117	—	1,285	5,300	1,031	4,732	13·8	29,902	32,146

APP. A, No. 2.

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ESSEX.											
Billericay	483	390	4	—	17	45	1	26	5·6	414	393
Braintree	586	468	1	—	19	33	23	42	11·1	444	472
Chelmsford	821	712	1	—	23	59	3	24	3·2	763	812
Colchester	1 001	626	2	—	36	102	9	228	23·5	626	673
Dunmow	376	309	—	—	12	24	3	28	8·2	347	341
Epping	719	609	3	—	16	50	1	40	5·7	594	627
Halstead	366	285	—	—	39	25	8	9	4·6	290	310
Lexden and Winstree ..	503	428	1	—	28	23	3	15	3·6	473	470
Maldon	561	443	—	—	48	28	10	32	7·5	528	494
Ongar	211	174	—	—	—	18	5	14	9·0	166	199
Orsett	979	515	1	—	245	105	14	99	11·5	504	973
Rochford	1,379	871	3	—	170	160	19	156	12·7	1,031	885
Romford	2,806	1,927	8	—	48	308	22	493	18·4	2,031	2,162
Saffron Walden ..	336	285	—	—	7	33	4	7	3·3	334	301
Tendring	1,216	896	1	—	62	137	30	100	10·7	951	898
West Ham	18,816	10,524	53	—	286	2,150	465	5,338	30·8	11,289	12,768
	31,159	19,452	78	—	1,056	3,305	619	6,649	23·3	20,775	22,877
GLOUCESTER.											
Barton Regis	410	288	1	—	15	37	31	38	16·8	289	363
Bristol	9,089	5,216	18	—	222	996	306	2,331	29·0	5,808	5,661
Cheltenham	1,155	601	1	—	225	102	5	221	19·6	704	688
Chipping Sodbury ..	463	321	—	—	17	41	13	71	18·1	355	408
Cirencester	445	379	2	—	11	38	6	9	3·4	391	410
Dursley	255	163	—	—	52	13	1	26	10·6	168	154
Gloucester	1,586	529	1	—	330	150	36	540	36·3	625	528
Newent	202	163	—	—	16	12	5	6	5·4	186	158
Northleach	171	140	—	—	10	15	3	3	3·5	159	149
Stow-on-the-Wold ..	178	141	—	—	20	13	2	2	2·2	159	134
Stroud	825	320	2	—	159	56	8	280	34·9	345	383
Tetbury	144	100	1	—	24	12	—	7	4·9	115	93
Tewkesbury	352	84	1	—	82	31	—	154	43·7	32	152
Thornbury	414	325	—	—	45	28	2	14	3·9	373	233
Westbury-on-Severn ..	681	289	—	—	267	53	5	67	10·6	255	326
Wheatenhurst	135	69	—	—	20	12	21	13	25·2	75	74
Winchcomb	215	146	—	—	50	15	—	4	1·9	167	148
	16,720	9,274	27	—	1,565	1,624	444	3,786	25·3	10,206	10,162
HEREFORD.											
Bromyard	239	201	—	—	4	16	5	13	7·5	216	246
Dore	165	130	—	—	10	14	1	10	6·7	168	154
Hereford	784	629	1	—	23	73	15	43	7·4	639	726
Kington	263	232	—	—	2	23	2	4	2·3	325	204
Ledbury	325	273	—	—	9	31	4	8	3·7	315	293
Leominster	304	258	—	—	12	25	2	7	3·0	260	285
Ross	390	318	1	—	28	22	3	18	5·4	362	321
Weobley	152	137	—	—	1	12	1	1	1·3	156	184
	2,622	2,178	2	—	89	216	33	104	5·2	2,441	2,377

App. A, No. 2.

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HERTFORD.											
Albans, St.	741	350	1	—	197	63	—	130	17·5	528	441
Barnet	1,409	1,077	2	—	46	107	31	146	12·6	964	1,112
Berkhampstead ..	363	251	1	—	54	35	5	17	6·1	278	293
Bishop Stortford ..	484	395	1	—	20	38	11	19	6·2	490	480
Buntingford	110	97	1	—	3	5	—	4	3·6	106	97
Hatfield	199	177	1	—	4	13	—	4	2·0	177	199
Hemel Hempstead ..	434	298	2	—	32	36	5	61	15·2	295	345
Hertford	405	350	—	—	8	30	4	13	4·2	354	346
Hitchin	686	576	—	—	34	59	—	17	2·5	579	618
Royston	345	293	—	—	12	30	—	10	2·9	344	326
Ware	488	413	—	—	11	40	6	18	4·9	484	455
Watford	1,318	922	4	—	65	121	13	193	15·6	909	1,110
Welwyn	59	50	—	—	—	5	—	4	6·8	57	60
	7,041	5,249	13	—	486	582	75	636	10·1	5,585	5,883
HUNTINGDON.											
Huntingdon	477	375	—	—	28	58	3	13	3·4	382	447
Ives, St.	350	314	—	—	13	22	1	—	0·3	314	307
Neots, St.	332	265	—	—	18	30	1	18	5·7	283	283
	1,159	954	—	—	59	110	5	31	3·1	979	1,037
KENT (EXTRA-METROPOLITAN).											
Ashford, East	313	269	—	—	16	20	—	8	2·6	269	262
Ashford, West	506	379	1	—	59	38	9	20	5·7	440	416
Blean	623	512	3	—	23	50	5	30	5·6	523	554
Bridge	254	212	—	—	2	20	6	14	7·9	210	234
Bromley	1,946	1,634	5	—	32	155	18	102	6·2	1,700	2,112
Canterbury	470	394	6	—	8	42	2	18	4·3	392	403
Cranbrook	278	218	—	—	11	20	3	26	10·4	268	234
Dartford	2,727	2,234	11	—	116	262	27	77	3·8	2,577	2,576
Dover	1,306	1,080	8	—	28	130	7	53	4·6	1,145	1,163
Eastry	720	625	1	—	12	64	1	17	2·5	630	656
Elham	1,225	956	4	—	40	124	18	83	8·2	1,072	944
Faversham	768	640	1	—	25	88	—	14	1·8	663	689
Gravesend and Milton	663	344	1	—	4	74	3	237	36·2	338	520
Hollingbourn	302	269	—	—	3	21	2	7	3·0	284	263
Hoo	127	110	—	—	—	13	2	2	3·1	106	116
Maidstone	1,218	790	1	—	56	97	1	273	22·5	826	1,001
Malling	712	606	—	—	17	62	1	26	3·8	686	673
Medway	2,629	2,059	1	—	77	303	17	172	7·2	2,211	2,081
Milton	885	685	2	—	55	71	3	19	2·6	725	715
Romney Marsh	158	130	1	—	5	9	5	8	8·2	132	124
Sevenoaks	694	557	3	—	20	68	12	34	6·6	573	591
Sheppey	543	422	—	—	4	59	22	36	10·7	498	416
Strood	1,279	1,079	2	—	51	105	7	35	3·3	1,207	1,210
Tenterden	215	172	1	—	9	21	6	6	5·6	217	208
Thanet, Isle of	1,536	1,162	2	—	147	144	11	70	5·3	1,157	1,199
Tonbridge	1,515	926	4	—	253	128	55	149	18·1	991	989
	23,562	18,464	58	—	1,073	2,188	243	1,536	7·6	19,840	20,349

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LANCASTER.											
Ashton-under-Lyne ..	4,869	2,865	7	—	390	667	57	883	19·3	3,247	2,952
Barrow-in-Furness ..	1,811	1,560	3	—	11	186	5	46	2·8	1,619	1,644
Barton-upon-Irwell ..	2,970	1,910	4	—	50	365	171	470	21·6	2,128	1,936
Blackburn	6,040	4,792	20	—	187	724	101	216	5·2	5,737	4,905
Bolton	7,454	6,449	17	—	51	771	14	152	2·2	7,140	6,351
Burnley	5,599	2,488	19	—	865	779	132	1,316	25·9	2,918	2,425
Bury	3,489	1,973	9	—	645	390	12	460	13·5	2,195	2,000
Chorley	1,713	1,415	3	—	12	187	25	71	5·6	1,525	1,533
Chorlton	10,210	6,472	37	—	62	1,301	116	2,222	22·9	7,296	6,493
Clitheroe	520	368	—	—	16	43	15	78	17·9	406	418
Fylde, The	2,550	1,679	6	—	75	312	79	399	18·7	1,608	1,882
Garstang	262	236	—	—	11	10	1	4	1·9	236	286
Haslingden	2,889	2,123	7	—	385	262	34	128	5·6	2,285	2,066
Lancaster	1,796	1,394	3	—	18	230	16	135	8·4	1,436	1,433
Leigh	3,023	2,487	5	—	20	379	5	127	4·4	2,639	2,148
Liverpool	5,174	4,097	10	—	1	779	8	279	5·6	4,394	4.186
Lunesdale	177	138	1	—	2	18	1	17	10·2	165	139
Manchester	4,590	3,144	11	—	8	699	73	655	15·9	3.324	2,960
Oldham	5,813	2,517	5	—	1,601	794	8	888	15·4	3,082	2,341
Ormskirk	2,607	2,241	17	—	24	251	16	58	2·8	2,322	2,223
Prescot	5,268	4,451	10	—	14	561	23	209	4·4	4,761	4,594
Preston	4,434	3,123	14	—	36	725	44	492	12·1	3,659	3,452
Prestwich	6,053	4,766	28	—	49	642	46	522	9·4	4,912	4,763
Rochdale	2,900	1,503	6	—	425	328	12	626	22·0	1,531	1,528
Salford	7,604	5,443	39	—	65	1,074	153	830	12·9	5,794	5,393
Todmorden	890	616	5	—	136	72	9	52	6·9	751	647
Toxteth Park	4,060	3,020	8	—	7	557	46	422	11·5	3,076	3,447
Ulverston	1,153	1,040	3	—	6	80	8	16	2·1	1,015	1,053
Warrington	3,571	2,753	15	—	18	502	40	243	8·0	2,394	2,615
West Derby	17,496	13,765	56	—	28	2,108	201	1,338	8·8	14,695	14,413
Wigan	7,055	5,553	12	—	79	973	106	332	6·2	5,863	5,679
	134,040	96,381	380	—	5,247	16,769	1,577	13,686	11·4	104,153	98,203
LEICESTER.											
Ashby-de-la-Zouch ..	1,476	678	—	—	252	176	22	348	25·1	699	698
Barrow-on-Soar ..	702	133	—	—	305	87	2	175	25·2	169	176
Billesdon	132	91	—	—	13	10	1	17	13·6	83	84
Blaby	685	148	—	—	360	80	2	95	14·2	230	171
Hinckley	772	266	—	—	255	88	—	163	21·1	266	319
Leicester	6,206	315	2	—	596	1,002	265	4,024	69·1	466	483
Loughborough	963	212	—	—	423	119	77	132	21·7	222	264
Lutterworth	267	173	—	—	57	20	1	16	6·4	456	189
Market Bosworth ..	565	209	1	—	234	62	13	46	10·4	218	225
Market Harborough ..	476	238	—	—	179	25	10	24	7·1	223	240
Melton Mowbray ..	587	370	—	—	132	44	4	37	7·0	446	416
	12,831	2,833	3	—	2,806	1,713	397	5,077	42·7	3,478	3,265
LINCOLN.											
Boston	1,072	711	3	—	237	77	8	36	4·1	1.033	1,009
Bourne	473	356	—	—	8	30	1	78	16·7	338	350
Caistor	389	285	—	—	60	32	5	7	3·1	312	259
Gainsborough	917	365	2	—	244	95	24	187	23·0	381	416
Glanford Brigg	1,350	723	2	—	390	158	8	69	5·7	767	772
Grantham..	876	679	2	—	70	72	8	45	6·1	694	705

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LINCOLN—*cont.*											
Grimsby	2,580	1,629	5	—	88	391	135	332	18·1	1,940	2,060
Holbeach	419	290	—	—	80	38	7	4	2·6	357	334
Horncastle	399	324	—	—	8	30	7	30	9·3	348	422
Lincoln	1,881	1,349	3	—	201	236	20	75	5·0	1,390	1,375
Louth	684	539	—	—	59	62	7	17	3·5	583	538
Sleaford	603	462	—	—	50	49	10	34	7·3	473	4·8
Spalding	553	333	—	—	143	50	5	22	4·9	469	375
Spilsby	553	491	3	—	3	47	2	7	1·6	518	522
Stamford	404	326	1	—	41	29	2	5	1·7	340	320
	13,158	8,862	21	—	1,662	1,396	249	948	9·1	9,939	9,925
MIDDLESEX (EXTRA-METROPOLITAN).											
Brentford	4,678	3,507	18	—	22	515	49	507	11·9	3,813	6,554
Edmonton..	9,532	5,850	23	—	158	990	173	2,338	26·3	6,016	7,004
Hendon	1,332	1,063	7	—	50	91	14	107	9·1	1,014	1,324
Staines	951	756	4	—	7	95	3	86	9·4	796	876
Uxbridge	1,037	851	3	—	15	105	10	53	6·1	914	935
Willesden	3,560	2,317	16	—	121	321	35	750	23·1	3,417	2,819
	21,090	14,404	71	—	373	2,117	284	3,841	19·6	14,969	19,512
MONMOUTH.											
Abergavenny	775	529	2	—	74	93	—	77	9·9	516	598
Bedwellty	3,142	2,218	2	—	72	377	147	326	15·1	2,408	2,466
Chepstow	497	357	—	—	40	44	8	48	11·3	350	384
Monmouth	813	506	2	—	166	83	9	47	6·9	653	623
Newport	3,663	2,735	5	—	148	417	66	293	9·8	2,838	3,079
Pontypool	1,573	1,098	—	—	106	181	64	124	12·0	896	994
	10,463	7,443	11	—	606	1,195	294	914	11·5	7,661	8,144
NORFOLK.											
Aylsham	423	318	—	—	33	39	4	9	3·1	381	388
Blofield	279	232	—	—	20	22	1	4	1·8	266	228
Depwade	512	417	1	—	36	38	5	15	3·9	473	380
Docking	446	362	—	—	33	37	5	9	3·1	401	337
Downham	470	406	1	—	1	38	1	23	5·1	394	420
Erpingham	563	401	—	—	66	49	21	25	8·2	423	470
Faith, St.	358	263	—	—	39	42	4	10	3·9	265	228
Flegg, East and West ..	283	236	—	—	9	31	3	4	2·5	274	276
Forehoe	367	201	—	—	16	20	—	30	11·2	171	213
Freebridge Lynn ..	309	257	—	—	22	21	2	7	2·9	253	239
Guiltcross..	217	184	—	—	10	14	2	7	4·1	220	207
Henstead	253	218	—	—	9	16	1	9	4·0	227	226
King's Lynn	556	79	—	—	53	74	—	350	62·9	76	138
Loddon and Clavering	313	271	1	—	7	29	2	3	1·6	292	284
Mitford and Launditch	563	455	1	—	33	55	7	13	3·4	505	515
Norwich	3,245	1,399	2	—	1,262	461	10	111	3·7	1,509	1,605
Smallburgh	424	360	—	—	22	33	—	9	2·1	371	380
Swaffham..	271	211	—	—	13	25	—	22	8·1	196	198
Thetford	328	315	—	—	36	24	2	11	3·4	302	360
Walsingham	508	400	—	—	50	38	2	18	3·9	416	398
Wayland	244	190	—	—	13	30	2	9	4·5	195	189
Yarmouth, Great ..	1,378	1,127	—	—	63	160	7	21	2·0	1,552	1,267
	12,269	8,332	6	—	1,836	1,296	81	716	6·5	9,161	8,934

—	Returns, 1900. Births.	Successfully Vaccinated.	Insusceptible of Vaccination.	Had Small-pox.	Number in respect of whom Certificates of conscientious objection have been received.	Died unvaccinated.	Vaccination postponed.	Remaining.	Children not finally accounted for (including cases postponed), per cent. of births.	Total number of Certificates of successful Primary Vaccination at ALL AGES received during each of the calendar years 1900 and 1901. 1900.	1901.
NORTHAMPTON.											
Brackley	251	150	1	—	27	16	22	35	22·7	85	121
Brixworth	269	146	—	—	15	20	1	87	32·7	157	161
Daventry	440	252	2	—	54	37	11	84	21·6	252	222
Hardingstone	301	146	—	—	101	23	3	28	10·3	152	156
Kettering	1,474	255	—	—	198	170	37	814	57·7	348	220
Northampton	2,419	319	—	—	534	257	11	1,298	54·1	435	526
Oundle	216	184	—	—	8	13	4	7	5·1	184	183
Peterborough	1,495	1,160	—	—	36	163	9	127	9·1	1,199	1,166
Potterspury	315	180	1	—	86	36	—	12	3·8	219	192
Thrapston.. .. .	400	163	—	—	186	23	7	21	7·0	163	179
Towcester..	266	128	—	—	81	15	5	37	15·8	117	159
Wellingborough.. ..	1,646	165	—	—	180	183	16	1,102	67·9	199	169
	9,492	3,848	4	—	1,506	966	126	3,652	39·8	3,510	3,454
NORTHUMBERLAND.											
Alnwick	621	487	2	—	6	64	18	44	10·0	443	576
Belford	133	124	—	—	—	5	4	—	3·0	130	110
Bellingham	136	111	—	—	8	11	—	6	4·4	124	92
Berwick-upon-Tweed	482	416	—	—	—	52	9	5	2·9	444	420
Castle Ward	846	328	2	—	44	80	23	419	49·3	746	748
Glendale	167	147	—	—	1	15	3	1	2·4	134	178
Haltwhistle	242	130	1	—	82	20	—	9	3·7	130	110
Hexham	910	596	1	—	118	111	15	67	9·0	603	652
Morpeth	1,964	832	1	—	25	311	15	780	40·5	887	822
Newcastle-on-Tyne ..	7,816	6,399	33	—	115	912	65	562	8·0	6,197	6,401
Rothbury	147	124	—	—	—	19	—	4	2·7	124	107
Tynemouth	5,764	3,994	28	—	185	713	141	703	14·6	4,126	4,343
	19,278	13,390	68	—	614	2,313	293	2,600	15·0	14,088	14,559
NOTTINGHAM.											
Basford	4,859	2,611	6	—	630	632	113	867	20·2	3,004	2,973
Bingham	308	253	2	—	28	18	1	6	2·3	276	253
East Retford	666	532	1	—	41	65	3	24	4·1	515	599
Mansfield	3,064	1,371	10	—	88	423	64	1,108	38·3	2,068	1,860
Newark	768	513	3	—	53	81	19	100	15·5	467	655
Nottingham	6,751	3,898	17	—	738	1,006	215	875	16·1	4,197	4,470
Southwell	470	358	1	—	20	55	8	28	7·7	364	368
Worksop	1,309	990	2	—	33	165	15	104	9·1	1,036	1,065
	18,195	10,526	42	—	1,630	2,447	438	3,112	19·5	11,927	12,252
OXFORD.											
Banbury	702	332	—	—	229	51	2	88	12·8	745	447
Bicester	281	203	—	—	24	21	7	26	11·7	250	208
Chipping Norton ..	362	225	—	—	55	36	3	43	12·7	414	290
Headington	916	788	3	—	26	71	2	26	3·1	783	746
Henley	582	470	1	—	48	34	7	22	5·0	525	468
Oxford	545	458	2	—	22	43	1	19	3·7	489	487
Thame	270	209	—	—	38	17	—	6	2·2	232	214
Witney	459	361	—	—	41	30	3	24	5·9	374	366
Woodstock	286	217	—	—	43	17	—	9	3·1	243	253
	4,403	3,263	6	—	526	320	25	263	6·5	4,055	3,479

APP. A, No. 2.

Digest of Vaccination Officers' Returns, 1900.

—	RETURNS, 1900. Births.	Successfully Vaccinated.	Insusceptible of Vaccination.	Had Small-pox.	Number in respect of whom Certificates of conscientious objection have been received.	Died unvaccinated.	Vaccination postponed.	Remaining.	Children not finally accounted for (including cases postponed), per cent. of births.	Total number of Certificates of successful Primary Vaccinnation at ALL AGES received during each of the calendar years 1900 and 1901. 1900.	1901.
RUTLAND.											
Oakham	250	223	2	—	8	14	—	3	1·2	256	202
Uppingham	206	167	—	—	21	13	—	5	2·4	173	179
	456	390	2	—	29	27	—	8	1·8	429	381
SALOP.											
Atcham	1,171	1,006	—	—	14	114	8	29	3·2	1,134	1,160
Bridgnorth	362	311	—	—	13	32	1	5	1·7	336	346
Church Stretton ..	107	97	2	—	1	5	1	1	1·9	116	105
Cleobury Mortimer ..	219	188	—	—	7	21	1	2	1·4	201	185
Clun	212	171	—	—	14	17	3	7	4·6	176	163
Drayton	334	273	—	—	8	45	2	6	2·4	294	267
Ellesmere	370	314	—	—	2	45	1	8	2·4	333	324
Ludlow	466	394	2	—	23	37	4	6	2·1	447	448
Madeley	694	623	1	—	5	54	4	7	1·6	632	631
Newport	342	290	—	—	1	33	3	15	5·3	309	303
Oswestry	732	642	3	—	9	57	4	17	2·9	656	670
Shifnal	299	269	—	—	2	24	2	2	1·3	280	283
Wellington	792	642	—	—	15	74	4	57	7·7	599	728
Wem	267	237	—	—	7	13	5	5	3·7	241	239
Whitchurch	296	249	3	—	7	16	7	14	7·1	252	235
	6,663	5,706	11	—	128	557	50	181	3·5	6,006	6,100
SOMERSET.											
Axbridge	953	464	1	—	193	94	31	170	21·1	501	521
Bath	1,668	1,121	8	—	94	152	107	186	17·6	1,266	1,223
Bridgwater	904	491	2	—	85	77	31	218	27·5	460	505
Chard	614	520	—	—	11	55	13	15	4·6	574	520
Clutton	782	563	3	—	108	59	8	42	6·4	560	558
Dulverton	93	83	—	—	3	6	—	1	1·1	87	104
Frome	479	344	1	—	81	34	2	17	4·0	555	396
Keynsham	1,040	507	—	—	39	91	12	391	38·7	456	458
Langport	347	270	2	—	39	27	1	8	2·6	281	271
Long Ashton	546	378	1	—	31	44	9	83	16·8	403	387
Shepton Mallet	372	285	—	—	41	21	4	21	6·7	300	309
Taunton	925	757	2	—	55	88	7	16	2·5	760	809
Wellington	445	361	—	—	38	29	5	12	3·8	347	372
Wells	514	316	—	—	37	47	21	93	22·2	296	450
Williton	351	276	—	—	18	32	12	13	7·1	281	337
Wincanton	340	273	1	—	15	24	6	21	7·9	259	247
Yeovil	670	498	—	—	89	41	16	23	5·8	568	487
	11,043	7,506	21	—	977	924	285	1,330	14·6	7,953	7,944
SOUTHAMPTON.											
Alresford	157	142	—	—	—	11	—	4	2·5	126	159
Alton	400	348	2	—	1	30	4	15	4·7	370	322
Alverstoke	823	710	1	—	2	92	3	16	2·2	704	707
Andover	351	250	—	—	48	27	8	18	7·4	311	288
Basingstoke	561	441	1	—	63	32	12	12	4·3	463	448
Catherington	56	49	—	—	2	2	—	3	5·4	56	60
Christchurch	1,234	869	3	—	25	111	25	201	18·3	951	995
Droxford	280	251	—	—	1	18	2	8	3·6	254	291
Fareham	486	418	—	—	3	40	1	24	5·1	418	455
Fordingbridge	145	116	—	—	11	7	—	11	7·6	115	145

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SOUTHAMPTON—*cont.*											
Hartley Wintney ..	667	552	1	—	19	69	1	25	3·9	550	734
Havant	258	229	1	—	3	15	3	7	3·9	254	203
Hursley	99	90	—	—	—	6	2	1	3·0	95	72
Kingsclere..	215	197	—	—	8	6	2	2	1·9	198	191
Lymington	294	240	—	—	6	21	1	26	9·2	269	262
New Forest	355	323	—	—	2	13	2	15	4·8	380	281
Petersfield..	306	265	—	—	4	20	10	17	8·8	260	265
Portsmouth	5,036	4,385	16	—	37	521	26	51	1·5	4,422	4,555
Ringwood..	187	163	2	—	2	12	1	7	4·3	154	179
Romsey	262	224	—	—	12	19	2	5	2·7	270	212
Southampton	1,751	1,398	7	—	28	215	18	85	5·9	1,534	1,483
South Stoneham ..	2,240	1,764	6	—	47	197	79	147	10·1	1,774	1,847
Stockbridge	155	141	—	—	6	4	—	4	2·6	130	122
Whitchurch	151	123	—	—	5	10	1	12	8·6	134	139
Wight, Isle of	1,772	1,419	4	—	106	116	27	100	7·2	1,526	1,380
Winchester, New ..	708	595	1	—	30	59	11	12	3·2	616	612
	18,949	15,692	45	—	471	1,673	240	828	5·6	16,313	16,416
STAFFORD.											
Burton-upon-Trent ..	2,725	1,403	1	—	103	276	1	941	34·6	1,543	1,558
Cannock	1,640	1,376	4	—	33	164	8	55	3·8	1,329	1,656
Cheadle	763	646	—	—	7	68	7	34	5·4	646	661
Leek	1,312	1,049	1	—	70	160	15	17	2·4	1,163	1,142
Lichfield	1,282	1,082	7	—	16	119	21	37	4·5	1,092	1,049
Newcastle-under-Lyme	1,282	1,094	1	—	6	148	14	19	2·6	1,139	1,042
Seisdon	467	388	1	—	16	38	4	20	5·1	411	388
Stafford	793	633	—	—	47	74	5	39	5·5	661	679
Stoke-upon-Trent ..	5,821	4,060	8	—	29	886	317	521	14·4	4,158	4,148
Stone	506	430	—	—	8	49	13	6	3·8	633	460
Tamworth	747	545	—	—	8	79	49	66	15·4	510	562
Uttoxeter	399	331	—	—	9	27	5	27	8·0	345	341
Walsall	4,094	2,672	35	—	65	633	65	624	16·8	2,665	3,321
West Bromwich ..	5,502	2,399	15	—	92	748	167	2,061	40·9	2,589	2,725
Wolstanton and Burslem	3,787	2,920	4	—	5	574	10	274	7·5	2,800	3,032
Wolverhampton ..	5,255	2,870	21	—	208	657	46	1,453	28·5	2,963	2,914
	36,379	23,898	98	—	722	4,700	747	6,214	19·1	24,655	25,678
SUFFOLK.											
Blything	650	583	—	—	15	44	3	6	1·4	605	556
Bosmere and Claydon..	364	289	1	—	14	33	7	20	7·4	289	214
Bury St. Edmunds :	398	290	—	—	29	39	18	22	10·1	284	400
Cosford	403	363	—	—	5	28	1	8	2·2	314	354
Hartismere	301	260	—	—	1	31	2	7	3·0	293	298
Hoxne	282	254	—	—	2	15	2	9	3·9	268	232
Ipswich	1,800	784	—	—	350	232	18	416	24·1	987	982
Mildenhall	234	214	—	—	—	14	2	4	2·6	207	198
Mutford and Lothingland	1,272	959	—	—	38	109	22	144	13·1	1,053	1,168
Plomesgate	479	406	1	—	14	35	5	18	4·8	456	401
Risbridge	415	354	1	—	17	37	1	5	1·4	350	343
Samford	336	299	1	—	5	29	—	2	0·6	307	266
Stow	487	417	1	—	21	42	1	5	1·2	440	429
Sudbury	600	512	—	—	25	46	4	13	2·8	530	498
Thingoe	371	331	—	—	6	27	2	5	1·9	329	381
Wangford	358	309	1	—	9	31	5	3	2·2	336	340
Woodbridge	588	460	4	—	14	42	25	43	11·6	514	511
	9,340	7,083	10	—	565	834	118	730	9·1	7,562	7,566

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SURREY (EXTRA-METROPOLITAN).											
Chertsey	975	780	2	—	13	76	12	92	10·7	773	885
Croydon	4,717	2,838	13	—	70	471	130	1,195	28·1	2,148	5,167
Dorking	377	285	—	—	56	23	4	9	3·4	315	347
Epsom	1,334	952	1	—	32	105	26	218	18·3	1,037	1,031
Farnham	1,435	1,197	12	—	14	139	6	67	5·1	1,257	1,435
Godstone	592	465	2	—	9	44	11	61	12·2	438	566
Guildford	1,476	1,137	3	—	109	125	29	73	6·9	1,076	1,345
Hambledon	480	417	3	—	10	37	—	13	2·7	436	418
Kingston	3,448	2,641	17	—	79	305	67	339	11·7	3,039	3,860
Reigate	941	698	1	—	124	68	7	43	5·3	782	780
Richmond	1,060	931	—	—	8	89	3	29	3·1	835	1,052
	16,835	12,341	54	—	524	1,482	295	2,139	14·5	12,246	16,836
SUSSEX.											
Battle	568	410	1	—	63	40	4	50	9·5	607	515
Brighton	2,482	1,793	5	—	69	301	59	255	12·7	1,773	1,897
Chichester	262	220	—	—	5	20	3	14	6·5	257	220
Cuckfield	537	455	3	—	12	40	13	14	5·0	512	475
Eastbourne	1,087	323	—	—	263	94	43	364	37·4	367	525
East Grinstead	425	258	—	—	47	28	35	57	21·6	236	331
East Preston	840	662	4	—	33	73	24	44	8·1	755	734
Hailsham	405	240	—	—	104	27	5	29	8·4	285	310
Hastings	1,280	913	2	—	147	109	11	98	8·5	985	890
Horsham	675	526	—	—	29	63	4	53	8·4	485	616
Lewes	493	229	—	—	150	45	7	62	14·0	160	414
Midhurst	308	268	—	—	4	19	6	11	5·5	306	264
Newhaven	283	175	—	—	77	17	5	9	4·9	187	157
Petworth	199	177	—	—	3	15	—	4	2·0	173	199
Rye	246	199	—	—	25	14	1	7	3·3	229	202
Steyning	1,694	1,329	—	—	48	132	29	156	10·9	1,408	1,515
Thakeham	159	138	3	—	2	9	3	4	4·4	151	149
Ticehurst	340	266	1	—	33	22	3	15	5·3	282	308
Uckfield	564	320	—	—	144	43	14	43	10·1	335	323
Westbourne	151	138	—	—	—	9	1	3	2·7	140	151
Westhampnett	431	380	—	—	4	34	6	7	3·0	385	405
	13,429	9,419	19	—	1,262	1,154	276	1,299	11·7	10,018	10,600
WARWICK.											
Alcester	515	428	1	—	33	47	—	6	1·2	490	438
Aston	10,464	7,537	62	—	49	1,432	130	1,254	13·2	7,981	8,010
Atherstone	589	282	—	—	29	78	34	166	34·0	296	220
Birmingham	8,147	5,471	27	—	29	1,363	58	1,199	15·4	5,799	5,685
Coventry	2,207	1,216	2	—	178	237	5	569	26·0	903	1,278
Foleshill	583	445	—	—	58	67	1	12	2·2	523	521
Meriden	243	181	—	—	12	23	1	26	11·1	206	218
Nuneaton	939	498	1	—	153	124	—	163	17·4	395	642
Rugby	847	252	—	—	30	94	19	452	55·6	239	324
Solihull	1,289	996	4	—	16	110	2	161	12·6	1,059	1,078
Southam	263	189	—	—	39	19	5	11	6·1	207	164
Stratford-on-Avon ..	449	358	1	—	22	44	8	16	5·3	479	369
Warwick	1,157	922	—	—	54	102	17	42	5·2	990	957
	27,672	18,775	98	—	702	3,740	280	4,077	15·7	19,637	19,904

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WESTMORLAND.											
East Ward	318	244	—	—	35	28	4	7	3·5	265	282
Kendal	943	837	—	—	14	73	7	12	2·0	901	837
West Ward	192	166	2	—	4	12	3	5	4·2	182	157
	1,453	1,247	2	—	53	113	14	24	2·6	1,348	1,276
WILTS.											
Amesbury..	162	122	—	—	20	16	1	3	2·5	129	147
Bradford-on-Avon ..	221	104	—	—	17	22	—	78	35·3	112	93
Calne	204	112	—	—	24	12	9	47	27·5	151	96
Chippenham	572	262	—	—	74	38	—	198	34·6	322	281
Cricklade and Wootton Bassett.	286	163	2	—	74	19	10	18	9·8	211	215
Devizes	490	267	—	—	150	30	11	32	8·8	263	324
Malmesbury	303	203	—	—	29	18	10	43	17·5	227	250
Marlborough	185	163	2	—	3	14	—	3	1·6	172	151
Mere	118	97	—	—	6	3	5	7	10·2	102	108
Pewsey	295	246	—	—	26	13	2	8	3·4	234	247
Salisbury	647	426	—	—	123	48	25	25	7·7	453	444
Swindon and Highworth.	1,757	800	—	—	660	120	37	140	10·1	833	979
Tisbury	177	146	1	—	1	10	1	18	10·7	159	158
Trowbridge and Melksham.	421	115	1	—	54	26	26	199	53·4	126	83
Warminster	255	213	—	—	17	20	—	5	2·0	235	253
Westbury and Whorwellsdown.	238	153	—	—	13	20	1	51	21·8	223	136
Wilton	222	167	—	—	37	14	2	2	1·8	191	168
	6,553	3,759	6	—	1,328	443	140	877	15·5	4,143	4,152
WORCESTER.											
Bromsgrove	924	774	2	—	26	83	15	24	4·2	786	872
Droitwich	470	412	—	—	4	35	—	19	4·0	431	445
Dudley	5,565	4,364	18	—	65	671	74	373	8·0	4,577	4,491
Evesham	500	325	—	—	134	30	3	8	2·2	343	366
Kidderminster	996	849	1	—	26	96	5	21	2·6	866	858
King's Norton	5,287	3,648	22	—	62	587	65	903	18·3	3,955	4,003
Martley	342	284	1	—	9	33	2	13	4·4	323	367
Pershore	324	282	1	—	7	23	1	10	3·4	294	282
Shipston-on-Stour ..	361	266	2	—	45	36	2	10	3·3	289	277
Stourbridge	3,098	2,617	14	—	29	347	28	63	2·0	2,653	2,761
Tenbury	181	153	—	—	1	15	7	5	6·6	149	156
Upton-on-Severn ..	516	417	1	—	30	46	11	11	4·3	414	500
Worcester	1,274	837	1	—	10	140	121	165	22·4	839	936
	19,840	15,228	63	—	448	2,142	334	1,625	9·9	15,919	16,296
YORK, EAST RIDING.											
Beverley	658	526	3	—	24	78	2	26	4·3	567	501
Bridlington	511	390	1	—	26	50	6	38	8·6	456	354
Driffield	452	365	3	—	24	45	2	13	3·3	426	383
Howden	333	277	—	—	4	46	2	4	1·8	326	271
Kingston-upon-Hull ..	2,626	1,485	10	—	22	366	32	713	28·3	1,458	1,765
Patrington	181	156	1	—	7	12	—	5	2·8	147	185
Pocklington	354	298	—	—	9	39	5	5	2·8	323	298
Sculcoates	5,565	4,409	29	—	40	740	30	317	6·2	4,837	4,668
Skirlaugh	221	187	1	—	—	30	—	3	1·4	183	224
York	2,560	1,999	12	—	40	299	39	171	8·2	2,011	2,142
	13,463	10,089	60	—	196	1,705	118	1,295	10·5	10,734	10,791

—	Returns, 1900. Births.	Successfully Vaccinated.	Insusceptible of Vaccination.	Had Small-Pox.	Number in respect of whom Certificates of conscientious objection have been received.	Died unvaccinated.	Vaccination postponed.	Remaining.	Children not finally accounted for (including cases postponed), per cent. of births.	Total number of Certificates of successful Primary Vaccination at ALL AGES received during each of the calendar years 1900 and 1901. 1900.	1901.
YORK, NORTH RIDING.											
Aysgarth	108	91	—	—	—	13	—	4	3·7	91	73
Bedale	189	165	3	—	7	11	1	2	1·6	168	192
Easingwold	206	161	—	—	1	15	10	19	14·1	167	180
Guisborough	1,420	1,072	6	—	41	144	15	152	11·7	1,091	970
Helmsley	113	95	—	—	2	10	2	4	5·3	85	132
Kirkby Moorside ..	122	99	1	—	7	10	2	3	4·1	99	67
Leyburn	130	112	—	—	3	14	—	1	0·8	127	119
Malton	529	428	1	—	33	48	3	16	3·6	491	458
Middlesbrough	5,125	3,627	15	—	36	788	167	492	12·9	3,760	3,631
Northallerton	273	233	—	—	13	19	3	5	2·9	255	248
Pickering	309	244	1	—	8	35	8	13	6·8	253	221
Reeth	52	47	—	—	1	3	1	—	1·9	55	39
Richmond..	276	237	—	—	2	18	6	13	6·9	283	275
Scarborough	1,282	524	3	—	351	162	2	240	18·9	604	450
Stokesley	260	225	—	—	2	21	1	11	4·6	203	197
Thirsk	328	279	—	—	7	30	4	8	3·7	307	277
Whitby	573	484	2	—	15	53	8	11	3·3	409	594
	11,305	8,123	32	—	529	1,394	233	994	10·9	8,448	8,123
YORK, WEST RIDING.											
Barnsley	4,181	3,303	24	—	24	529	37	264	7·2	3,305	3,567
Bierley, North	3,068	2,205	12	—	116	290	51	414	15·1	2,863	2,410
Bradford	5,525	3,698	14	—	281	604	98	830	16·8	4,205	3,876
Bramley	2,351	1,891	19	—	76	251	28	86	4·8	1,911	1,852
Dewsbury	4,357	1,615	4	—	438	606	39	1,655	38·9	1,170	1,632
Doncaster	2,691	2,015	11	—	160	377	30	98	4·8	2,118	2,244
Ecclesall Bierlow ..	5,401	4,255	53	—	45	690	51	317	6·8	4,308	4,304
Goole	846	711	3	—	3	83	4	42	5·4	748	765
Halifax	4,353	842	5	—	28	513	—	2,965	68·1	1,254	758
Hemsworth	870	704	1	—	7	97	4	57	7·0	769	789
Holbeck	1,156	874	7	—	22	156	29	68	8·4	918	843
Huddersfield	4,071	3,386	30	—	155	319	37	144	4·4	3,521	3,190
Hunslet	2,732	2,123	16	—	66	381	30	136	6·1	2,172	2,167
Keighley	1,831	474	3	—	981	205	1	167	9·2	481	556
Knaresborough	1,034	624	—	—	71	126	87	126	20·6	705	634
Leeds	7,587	5,541	35	—	138	955	142	776	12·1	5,536	5,482
Ouseburn, Great ..	231	187	—	—	5	31	2	6	3·5	196	200
Pateley Bridge	201	159	—	—	4	10	1	27	13·9	270	230
Penistone	454	380	—	—	9	40	12	13	5·5	389	417
Pontefract	2,569	2,054	7	—	48	320	22	118	5·4	1,998	2,254
Ripon	363	310	—	—	10	31	2	10	3·3	298	287
Rotherham	4,098	3,451	21	—	31	455	15	125	3·4	3,486	3,590
Saddleworth	393	246	—	—	96	27	4	20	6·1	254	249
Sedbergh	76	66	—	—	—	7	2	1	3·9	76	55
Selby	464	410	—	—	5	39	2	8	2·2	456	390
Settle	341	275	—	—	31	20	4	11	4·4	335	314
Sheffield	8,154	6,502	59	—	55	1,035	45	458	6·2	6,664	6,473
Skipton	1,147	482	1	—	352	110	15	187	17·6	713	560
Tadcaster	948	808	6	—	9	93	1	31	3·4	807	829
Thorne	445	316	—	—	24	42	19	44	14·2	295	428
Wakefield..	3,616	3,027	9	—	65	386	25	104	3·6	3,019	3,199
Wetherby	345	288	—	—	9	43	2	3	1·4	345	342
Wharfedale	1,395	1,092	3	—	44	118	17	121	9·9	1,233	1,229
Wortley	1,651	1,302	2	—	15	208	13	111	7·5	1,249	1,259
	78,965	55,616	345	—	3,423	9,167	871	9,543	13·2	58,065	57,380

APP. A, No. 2.

Digest of Vaccination Officers' Returns, 1900.

—	Returns, 1900.									Total number of Certificates of successful Primary Vaccination at ALL AGES received during each of the calendar years 1900 and 1901.	
	Births.	Successfully Vaccinated.	Insusceptible of Vaccination.	Had Small-pox.	Number in respect of whom Certificates of conscientious objection have been received.	Died unvaccinated.	Vaccination postponed.	Remaining.	Children not finally accounted for (including cases postponed), per cent. of births.	1900.	1901.
ANGLESEY.											
Anglesey	321	380	1	—	—	33	2	5	2·2	295	287
Holyhead	532	456	—	—	—	53	7	16	4·3	383	460
	853	736	1	—	—	86	9	21	3·5	678	747
BRECKNOCK.											
Brecknock	391	344	—	—	1	32	4	10	3·6	371	350
Builth	221	187	—	—	2	16	7	9	7·2	181	218
Crickhowell	689	604	—	—	7	49	4	25	4·2	711	457
Hay	203	152	—	—	13	21	4	13	8·4	195	160
	1,504	1,287	—	—	23	118	19	57	5·1	1,458	1,185
CARDIGAN.											
Aberayron	213	174	—	—	1	26	4	8	5·6	212	134
Aberystwith	454	377	—	—	6	43	8	15	5·1	398	438
Cardigan	309	270	—	—	7	25	1	6	2·3	380	315
Lampeter	209	184	—	—	—	20	1	4	2·4	163	201
Tregaron	177	154	—	—	—	18	1	4	2·8	162	129
	1,362	1,159	—	—	14	137	15	37	3·8	1,315	1,217
CARMARTHEN.											
Carmarthen	816	724	—	—	2	81	5	4	1·1	710	730
Llandilo Fawr	750	665	—	—	—	80	2	3	0·7	725	646
Llandovery	219	190	—	—	—	27	2	—	0·9	115	123
Llanelly	1,804	1,583	—	—	4	169	28	20	2·7	1,784	1,431
Newcastle-in-Emlyn ..	417	362	—	—	2	35	7	11	4·3	399	307
	4,006	3,524	—	—	8	392	44	38	2·0	3,733	3,237
CARNARVON.											
Bangor and Beaumaris	987	869	2	—	3	107	—	6	0·6	958	864
Carnarvon	1,170	1,017	—	—	3	129	11	10	1·8	1,452	1,001
Conway	848	702	—	—	7	109	7	23	3·5	747	753
Pwllheli	444	385	—	—	1	43	2	13	3·4	471	454
	3,449	2,973	2	—	14	388	20	52	2·1	3,628	3,072
DENBIGH.											
Llanrwst	348	288	—	—	—	43	6	11	4·9	302	285
Ruthin	263	233	—	—	—	24	2	4	2·3	234	227
Wrexham	2,496	2,139	3	—	8	268	21	57	3·1	2,099	1,993
	3,107	2,660	3	—	8	335	29	72	3·3	2,635	2,505

APP. A, No. 2.

Digest of Vaccination Officers' Returns, 1900

—	Returns, 1900. Births.	Successfully Vaccinated.	Insusceptible of Vaccination.	Had Small-pox.	Number in respect of whom Certificates of conscientious objection have been received.	Died unvaccinated.	Vaccination postponed.	Remaining.	Children not finally accounted for (including cases postponed), per cent. of births.	Total number of Certificates of successful Primary Vaccination at ALL AGES received during each of the calendar years 1900 and 1901. 1900.	1901.
FLINT.											
Asaph, St.	688	580	2	–	2	75	4	25	4·2	552	567
Hawarden	588	518	2	—	1	52	6	9	2·6	496	468
Holywell	1,179	1,014	1	—	—	112	26	26	4·4	1,121	1,038
	2,455	2,112	5	—	3	239	36	00	3·9	2,169	2,073
GLAMORGAN.											
Bridgend and Cowbridge	2,128	1,668	4	—	8	193	157	99	12·0	1,467	1,713
Cardiff	7,306	5,540	19	—	144	679	16	908	12·6	6,991	5,816
Gower	338	2·9	—	—	1	34	2	12	4·1	276	313
Merthyr Tydfil	4,960	3,878	6	—	29	574	143	330	9·5	3,956	3,766
Neath	2,442	2,017	—	—	16	254	63	93	6·4	1,912	2,049
Pontardawe	938	821	—	—	3	101	6	7	1·4	839	821
Pontypridd	7,679	5,587	8	—	30	1,053	109	892	13·0	5,728	6,126
Swansea	3,586	2,884	3	—	21	402	5	271	7·7	2,792	3,276
	29,377	22,684	40	—	252	3,289	501	2,611	10·6	22,961	23,880
MERIONETH.											
Bala	129	98	—	—	2	13	12	4	12·4	91	133
Corwen	408	341	—	—	1	44	10	12	5·4	346	365
Dolgelly	336	290	1	—	1	26	2	6	2·5	302	284
Festiniog	820	570	—	—	—	94	6	150	19·0	677	537
	1,683	1,299	1	—	4	177	30	172	12·0	1,416	1,319
MONTGOMERY.											
Forden	362	315	—	—	5	33	6	3	2·5	317	305
Llanfyllin	427	390	—	—	1	31	3	2	1·2	382	383
Machynlleth	260	219	—	—	—	31	4	6	3·8	243	240
Newtown and Llanidloes	570	451	—	—	3	62	10	44	9·5	437	441
	1,619	1,375	—	—	9	157	23	55	4·8	1,379	1,389
PEMBROKE.											
Haverfordwest	865	699	—	—	1	103	10	52	7·2	833	787
Narberth	396	370	—	—	—	24	—	2	0·5	329	379
Pembroke	819	714	1	—	1	67	15	21	4·4	841	734
	2,080	1,783	1	—	2	194	25	75	4·8	2,003	1,900
RADNOR.											
Knighton	315	220	—	—	13	34	7	41	15·2	238	140
Rhayader	248	97	1	—	1	24	1	124	50·4	103	70
	563	317	1	—	14	58	8	165	30·7	341	210

ANALYSIS OF VACCINATION OFFICERS' RETURNS,

1893–1900.

No.

Analysis of Vaccination

—	Number of Births in 1900.	Percentages of Births: Certificates of "Successful Vaccination." (1) 1893-97.	1898.	1899.	1900.	Certificates of "Conscientious Objection." (2) 1898.	1899.	1900.
England and Wales ..	927,222	67·7	61·0	66·4	68·7	5·1	3·6	4·3
Ditto (excluding Metropolitan Unions).	795,575	68·1	62·2	67·7	69·9	5·8	4·0	4·8
Metropolitan Unions ..	131,647	65·4	53·8	58·8	61·7	1·4	1·0	1·0
Counties.								
England:								
Bedford	4,369	15·3	14·9	33·1	30·1	16·4	18·1	20·2
Berks	6,666	78·9	64·4	63·0	65·6	2·7	3·6	3·9
Buckingham	4,359	61·8	60·0	65·0	64·9	13·1	15·5	18·6
Cambridge	5,002	81·1	74·9	77·2	80·3	5·4	4·5	4·9
Chester	21,645	82·1	80·1	81·0	83·3	1·5	1·3	1·2
Cornwall	7,709	63·5	62·8	70·3	76·3	1·4	2·3	3·2
Cumberland	7,451	72·3	67·4	71·5	74·0	4·4	5·5	5·5
Derby	14,638	52·2	45·1	51·3	51·0	3·1	3·6	3·5
Devon	15,658	81·4	72·5	74·8	79·4	1·4	1·6	2·2
Dorset	4,524	76·6	70·9	78·0	78·5	13·9	3·4	4·7
Durham	41,669	70·2	63·9	68·2	70·1	2·9	2·8	3·1
Essex	31,159	69·9	53·0	61·2	62·4	3·2	3·0	3·4
Gloucester	16,720	56·3	43·1	53·7	55·5	10·2	6·9	9·4
Hereford	2,622	82·6	76·0	80·8	83·1	2·3	2·4	3·4
Hertford	7,041	70·6	62·9	73·1	74·5	5·9	5·2	6·9
Huntingdon..	1,159	85·3	82·7	82·1	82·3	3·0	4·4	5·1
Kent (extra-metropolitan)	23,562	77·2	71·9	75·9	78·4	3·7	4·2	4·6
Lancaster	134,040	65·4	62·1	69·2	71·9	6·9	3·5	3·9
Leicester	12,831	9·2	9·5	19·0	22·1	28·4	15·3	21·9
Lincoln	13,158	63·1	54·6	65·2	67·4	16·7	11·1	12·8
Middlesex (extra-metropolitan).	21,090	72·7	59·2	65·6	68·3	1·5	1·6	1·8
Monmouth	10,463	73·3	66·9	69·7	71·1	3·6	4·3	5·8
Norfolk	12,269	58·4	54·3	68·5	67·9	18·4	12·5	15·0
Northampton	9,492	25·7	21·4	33·5	34·2	33·3	12·9	15·9
Northumberland	19,278	72·3	62·8	68·7	69·5	2·2	2·4	3·2

* In the Returns for the years 1893–97 the Number of Certificates of Conscientious Objection finally accounted for," but allowance has been made for these in the "Total Unvaccinated."

3.

OFFICERS' RETURNS, 1893–1900.

IN RESPECTIVE YEARS.

Children not finally accounted for. (3)				Total Unvaccinated. (Col. 2 + Col. 3.)				—
* 1893-97.	1898.	1899.	1900.	* 1893-97.	1898.	1899.	1900.	
20·3	21·5	17·2	15·6	21·0	26·6	20·8	19·9	ENGLAND AND WALES.
19·7	19·6	15·4	13·9	20·5	25·4	19·4	18·7	Ditto (excluding Metropolitan Unions).
23·9	33·0	27·7	25·8	23·9	34·4	28·7	26·8	METROPOLITAN UNIONS.
								COUNTIES.
								ENGLAND:
70·6	54·5	36·4	39·4	73·6	70·9	54·5	59·6	Bedford.
12·2	23·1	22·9	21·2	12·3	24·8	26·5	25·1	Berks.
27·1	17·1	10·5	8·4	28·9	30·2	26·0	27·0	Buckingham.
9·5	12·7	8·5	6·2	9·6	15·1	13·0	11·1	Cambridge.
6·5	5·9	5·4	4·6	6·7	7·4	6·7	5·8	Chester.
25·2	22·7	15·5	10·4	25·4	24·1	17·8	13·6	Cornwall.
17·0	17·4	12·8	10·2	17·6	21·8	18·3	15·7	Cumberland.
35·6	38·7	32·1	33·1	36·1	41·8	35·7	36·6	Derby.
9·0	16·0	11·8	8·7	9·1	17·4	13·4	10·9	Devon.
15·5	8·2	11·7	9·5	15·6	22·1	15·1	14·2	Dorset.
17·2	18·6	14·8	13·8	17·5	21·5	17·6	16·9	Durham.
20·3	33·3	24·1	23·3	20·6	36·5	27·1	26·7	Essex.
31·3	35·4	27·5	26·3	32·6	45·6	34·4	34·7	Gloucester.
8·6	12·1	7·6	5·2	8·7	14·4	10·0	8·6	Hereford.
20·3	21·8	12·6	10·1	21·2	27·7	17·8	17·0	Hertford.
6·0	5·9	4·3	3·1	6·0	8·9	8·7	8·2	Huntingdon.
13·1	13·7	8·8	7·6	13·4	17·4	13·0	12·2	Kent(extra-metropolitan).
20·4	16·8	12·7	11·4	21·7	23·7	16·2	15·3	Lancaster.
72·0	47·5	50·6	42·7	75·6	75·9	65·9	64·6	Leicester.
22·4	15·1	10·9	9·1	24·8	31·8	22·0	21·9	Lincoln.
18·4	28·6	20·6	19·6	18·5	30·1	22·2	21·4	Middlesex (extra-metropolitan).
15·6	18·6	12·4	11·5	16·0	22·2	16·7	17·3	Monmouth.
27·2	13·9	7·1	6·5	30·0	32·3	19·6	21·5	Norfolk.
58·4	33·0	41·9	39·8	62·8	66·3	54·8	55·7	Northampton.
15·1	21·0	14·7	15·0	15·3	23·2	17·1	18·2	Northumberland.

received in respect of the children born in 1897 has not been included in the Percentages "Not

APP. A, No. 3.

Analysis of Vaccination Officers' Returns, 1893–1900.

—	Number of Births in 1900.	Percentages of Births						
		Certificates of "Successful Vaccination." (1)				Certificates of "Conscientious Objection." (2)		
		1893-97.	1898.	1899.	1900.	1898.	1899.	1900.
COUNTIES—*cont.*								
ENGLAND—*cont.*								
Nottingham..	18,195	56·5	45·0	54·5	57·8	13·0	7·0	9·0
Oxford	4,403	71·7	69·7	74·6	74·1	11·3	10·1	11·9
Rutland	456	85·5	84·1	86·1	85·5	3·3	5·5	6·4
Salop	6,663	80·1	79·3	81·9	85·6	1·4	1·3	1·9
Somerset	11,043	68·2	62·5	66·3	68·0	6·7	8·1	8·9
Southampton	18,949	81·4	75·2	78·9	82·9	2·7	2·6	2·5
Stafford	36,379	62·6	56·6	65·6	65·7	3·1	1·8	2·0
Suffolk	9,340	77·0	68·0	75·5	75·8	5·3	4·7	6·1
Surrey (extra-metropolitan).	16,835	71·7	62·3	65·8	73·3	2·8	3·1	3·1
Sussex..	13,429	70·8	64·9	66·4	70·1	6·3	7·0	9·4
Warwick	27,672	67·5	61·3	64·6	67·8	2·1	1·8	2·5
Westmorland	1,453	87·9	85·7	83·6	85·8	2·7	3·6	3·6
Wilts	6,553	59·2	43·0	57·3	57·4	18·7	14·9	20·3
Worcester	19,840	77·6	72·4	74·4	76·7	2·3	1·9	2·3
York, E. Riding	13,463	75 3	70·6	76·6	74·9	4·6	1·0	1·5
York, N. Riding	11,305	76·4	71·9	73·5	71·8	6·4	3·7	4·7
York, W. Riding	78,965	66·6	63·2	69·0	70·4	5·1	3·6	4·8
WALES:								
Anglesey	853	86·4	87·2	86·1	86·3	0·9	0·1	—
Brecknock	1,504	79·6	74·3	75·1	85·6	1·1	1·5	1·5
Cardigan	1,362	83·4	83·7	84·3	85·1	0·9	1·2	1·0
Carmarthen..	4,006	86·0	86·0	84·7	88·0	0·2	0·3	0·2
Carnarvon	3,449	81·9	77·1	82·8	86·2	0·3	0·5	0·4
Denbigh	3,107	84·2	82·2	84·5	85·6	0·4	0·2	0·3
Flint	2,455	82·2	82·4	84·6	86·0	0·2	0·1	0·1
Glamorgan	29,377	82·3	77·1	72·6	77·2	0·6	0·8	0·9
Merioneth	1,683	82·5	69·9	79·4	77·2	0·3	0·4	0·2
Montgomery	1,619	86·1	84·8	84·1	84·9	0·6	0·2	0·6
Pembroke	2,080	82·8	79·5	83·4	85·7	0·2	0·3	0·1
Radnor	563	50·5	58·9	63·6	56·3	0·8	2·2	2·5

* In the Returns for the years 1893-97 the Number of Certificates of Conscientious Objection finally accounted for," but allowance has been made for these in the "Total Unvaccinated."

IN RESPECTIVE YEARS.

Children not finally accounted for. (3)				Total Unvaccinated. (Col. 2 + Col. 3.)				—
1893-97.*	1898.	1899.	1900.	1893-97.*	1898.	1899.	1900.	
								COUNTIES—*cont.*
								ENGLAND—*cont.*
28·2	27·8	23·4	19·5	30·7	40·8	30·4	28·5	Nottingham.
17·8	11·1	6·7	6·5	19·4	23·4	16·8	18·4	Oxford.
5·3	3·7	1·2	1·8	5·5	7·0	6·7	8·2	Rutland.
10·7	9·4	7·0	3·5	11·0	10·8	8·8	5·4	Salop.
21·9	21·3	15·1	14·6	22·7	28·0	23·2	23·5	Somerset.
9·5	12·2	7·3	5·6	9·6	14·9	9·9	8·1	Southampton.
23·9	26·0	18·2	19·1	24·1	29·1	20·0	21·1	Stafford.
13·3	16·4	9·7	9·1	13·7	21·7	14·4	15·2	Suffolk.
19·6	24·5	20·5	14·5	19·9	27·3	23·6	17·6	Surrey (extra-metropolitan).
19·5	18·8	16·1	11·7	20·2	25·1	23·1	21·1	Sussex.
19·3	22·5	18·8	15·7	19·8	24·6	20·6	18·2	Warwick.
3·9	3·7	3·6	2·6	4·0	6·4	7·2	6·2	Westmorland.
30·2	30·0	18·6	15·5	33·2	48·7	33·6	35·8	Wilts.
11·4	14·2	11·6	9·9	11·6	16·5	13·5	12·2	Worcester.
12·1	12·0	10·8	10·5	12·6	16·6	11·8	12·0	York, E. Riding.
12·3	10·0	9·7	10·9	12·4	16·4	13·4	15·6	York, N. Riding
20·6	18·5	14·3	13·2	21·2	23·6	17·9	17·5	York, W. Riding.
								WALES:
4·7	5·0	3·1	3·5	4·7	5·9	3·2	3·5	Anglesey.
10·1	16·8	12·1	5·1	10·2	17·9	13·6	6·6	Brecknock.
6·6	5·3	3·1	3·8	6·6	6·2	4·3	4·8	Cardigan.
3·9	3·0	2·1	2·0	3·9	3·2	2·4	2·2	Carmarthen.
6·9	10·3	4·3	2·1	6·9	10·5	4·8	2·5	Carnarvon.
4·9	5·7	3·8	3·3	4·9	6·1	4·0	3·6	Denbigh.
8·3	6·4	4·7	3·9	8·3	6·6	4·8	4·0	Flint.
6·1	10·3	11·3	10·6	6·1	10·9	12·1	11·5	Glamorgan.
5·2	18·5	8·1	12·0	5·2	18·8	8·5	12·2	Merioneth.
5·0	6·1	5·3	4·8	5·0	6·7	5·5	5·4	Montgomery.
6·9	10·0	6·2	4·8	6·9	10·2	6·5	4·9	Pembroke.
38·1	32·3	27·6	30·7	38·2	33·1	29·8	33·2	Radnor.

received in respect of the children born in 1897 has not been included in the Percentages "Not

App. A, No. 3.

Analysis of Vaccination Officers' Returns, 1893–1900.

METROPOLITAN UNIONS.	Number of Births in 1900.	PERCENTAGES OF BIRTHS						
		Certificates of "Successful Vaccination." (1)				Certificates of "Conscientious Objection." (2)		
		1893-97.	1898.	1899.	1900.	1898.	1899.	1900.
Bethnal Green	4,625	19·2	20·2	38·5	38·2	0·2	0·4	0·4
Camberwell	7,251	62·6	48·1	60·1	65·2	1·2	1·1	1·0
Chelsea	2,254	77·9	71·3	74·1	74·1	1·5	1·1	1·3
Fulham	4,552	79·9	73·6	73·3	75·7	2·1	1·4	1·4
George, St., Hanover Square	2,361	84·9	79·2	79·1	82·2	2·8	1·0	1·2
George, St., in the East ..	2,178	68·4	56·4	53·4	58·6	0·3	0·1	—
Giles, St., and St. George ..	1,025	69·0	56·3	58·5	59·0	0·8	0·7	0·2
Greenwich	5,590	81·9	70·2	72·8	75·0	2·0	1·1	1·2
Hackney	7,200	30·0	37·1	48·4	46·8	1·1	0·9	1·0
Hammersmith	3,007	†	74·9	75·7	80·5	1·8	1·8	1·2
Hampstead	1,623	81·9	74·7	78·5	81·5	1·8	2·0	2·3
Holborn	4,557	69·7	43·7	54·9	60·7	0·7	1·0	0·6
Islington	9,316	69·9	57·2	59·0	64·2	1·1	1·0	1·3
Kensington	3,594	78·7	74·7	78·2	80·3	1·5	0·9	1·1
Lambeth	9,202	63·7	57·1	61·8	68·1	1·5	1·2	1·2
Lewisham	3,323	71·2	60·9	65·7	66·7	2·7	2·0	2·2
London, City of	403	76·9	63·2	70·9	72·2	7·5	2·3	2·0
Marylebone	4,008	74·4	72·2	68·2	72·4	0·6	0·7	0·4
Mile End Old Town	4,308	32·2	20·1	18·6	20·8	0·6	0·5	0·3
Olave, St.	4,459	67·7	56·9	62·6	64·8	1·3	0·7	0·5
Paddington	2,903	80·8	74·9	73·9	75·6	2·5	1·3	1·1
Pancras, St.	6,474	74·2	51·7	50·3	56·1	1·5	0·9	1·0
Poplar	5,[illegible]67	56·8	21·8	35·6	36·1	0·2	0·5	0·5
Shoreditch	4,015	43·1	17·3	32·7	32·0	0·4	0·2	0·2
Southwark	7,012	68·0	53·6	54·7	58·2	0·9	0·7	1·0
Stepney	1,852	54·4	37·6	38·7	41·1	0·5	0·3	0·2
Strand	354	72·6	61·8	64·3	70·9	1·4	—	0·8
Wandsworth and Clapham..	10,986	70·3	56·3	62·7	65·6	1·8	1·7	1·7
Westminster	665	71·3	74·5	75·7	79·4	1·8	1·1	1·2
Whitechapel	2,920	85·8	79·2	75·4	78·0	1·1	0·4	0·3
Woolwich	3,663	86·3	77·7	80·5	82·3	4·4	2·0	2·4
	131,647	65·4	53·8	58·7	61·7	1·4	1·0	1·0

[a] In the Returns for the years 1893-97 the Number of Certificates of Conscientious Objection finally accounted for," but allowance has been made for these in the "Total Unvaccinated."

† This Union was constituted on 26th March, 1899. It previously formed part of Fulham.

App. A, No. 3.

Analysis of Vaccination Officers' Returns, 1898 1900.

IN RESPECTIVE YEARS.

Children not finally accounted for. (3)				Total Unvaccinated. (Col. 2 + Col. 3.)				METROPOLITAN UNIONS.
* 1893-97.	1898.	1899.	1900.	* 1893-97.	1898.	1899.	1900.	
68·2	66·8	47·8	48·8	68·2	67·0	48·2	49·2	Bethnal Green.
27·3	40·0	28·6	22·0	27·3	41·2	29·7	23·0	Camberwell.
12·0	15·8	13·8	14·7	12·1	17·3	14·9	16·0	Chelsea.
8·9	13·3	11·2	12·3	8·9	15·4	12·6	13·7	Fulham.
5·3	8·3	8·0	5·9	5·3	11·1	9·0	7·1	George, St., Hanover Square.
21·2	34·3	34·9	33·5	21·2	34·6	35·0	33·5	George, St., in the East.
19·8	31·7	32·3	33·4	19·8	32·5	33·0	33·6	Giles, St., and St. George.
7·7	15·2	13·1	12·6	7·7	17·2	14·2	13·8	Greenwich.
61·5	47·9	37·7	39·4	61·5	49·0	38·6	40·4	Hackney.
†	12·0	9·9	7·9	†	13·8	11·7	9·1	Hammersmith.
8·2	13·6	8·3	8·7	8·3	15·4	10·3	11·0	Hampstead.
19·3	43·1	30·8	27·9	19·3	43·8	31·8	28·5	Holborn.
19·0	30·0	28·2	24·9	19·0	31·1	29·2	26·2	Islington.
11·1	12·0	9·3	8·1	11·1	13·5	10·2	9·2	Kensington.
24·7	29·1	24·0	19·4	24·7	30·6	25·2	20·6	Lambeth.
19·1	26·1	20·6	18·5	19·1	27·8	22·6	20·7	Lewisham.
13·1	17·9	16·0	12·2	13·3	25·4	18·3	14·2	London, City of.
15·3	17·4	20·2	17·3	15·3	18·0	20·9	17·7	Marylebone.
57·1	68·3	69·4	67·7	57·1	68·9	69·9	68·0	Mile End Old Town.
21·4	31·2	22·9	21·3	21·4	32·5	23·6	21·8	Olave, St.
9·5	12·2	13·3	12·4	9·5	14·7	14·6	15·5	Paddington.
16·3	35·2	35·2	31·9	16·3	36·7	36·1	32·9	Pancras, St.
31·4	63·4	49·6	48·5	31·4	63·6	50·1	49·0	Poplar.
43·9	68·4	52·2	52·8	43·9	68·8	52·4	53·0	Shoreditch.
19·4	31·7	29·6	26·6	19·4	32·6	30·3	27·6	Southwark.
34·2	48·1	46·6	44·4	34·2	48·6	46·9	44·6	Stepney.
15·4	23·8	19·7	18·4	15·4	25·2	19·7	19·2	Strand.
19·0	30·4	23·4	21·3	19·1	32·2	25·1	23·0	Wandsworth and Clapham.
19·9	15·6	13·7	11·0	19·9	17·4	14·8	12·2	Westminster.
5·7	10·7	14·1	12·8	5·7	11·8	14·5	13·1	Whitechapel.
4·2	5·8	6·3	5·1	4·3	10·2	8·3	7·5	Woolwich.
23·9	33·0	27·7	25·8	23·9	34·4	28·7	26·8	

received in respect of the children born in 1897 has not been included in the Percentages "Not

App. A, No. 3.

Analysis of Vaccination Officers' Returns, 1893–1900.

—	Number of Births in 1900.	Percentages of Births: Certificates of "Successful Vaccination." (1) 1893–97.	1898.	1899.	1900.	Certificates of "Conscientious Objection." (2) 1898.	1899.	1900.
BEDFORD.								
Ampthill	521	46·3	32·2	61·2	58·0	34·7	12·9	21·7
Bedford	1,296	20·0	15·9	21·4	17·5	16·8	1·7	1·1
Biggleswade	740	12·6	27·2	70·2	66·7	1·8	17·4	22·6
Leighton Buzzard	414	4·2	20·7	53·1	45·4	59·2	28·3	37·4
Luton	1,399	2·3	2·3	7·9	7·4	5·8	33·3	31·0
	4,369	15·3	14·9	33·1	30·1	16·4	18·1	20·2
BERKS.								
Abingdon	401	89·5	86·8	83·7	83·5	1·6	2·8	2·7
Bradfield	414	88·9	82·4	76·2	80·0	3·5	6·1	5·3
Easthampstead	332	84·9	84·8	86·4	86·7	1·5	2·2	1·8
Faringdon..	334	78·1	77·1	76·1	76·6	1·7	1·2	5·4
Hungerford and Ramsbury ..	352	90·3	86·8	86·9	88·9	2·3	0·9	3·1
Maidenhead	564	76·4	68·7	70·0	72·7	11·2	12·3	13·6
Newbury	433	82·5	82·4	81·7	83·6	2·1	3·5	5·5
Reading	1,886	64·4	22·6	20·4	24·7	1·5	3·3	1·5
Wallingford	291	89·5	83·1	86·3	89·0	2·9	2·2	2·4
Wantage	373	84·7	81·5	82·8	84·2	4·0	2·6	2·4
Windsor	877	82·1	74·9	77·6	81·1	2·0	2·7	2·7
Wokingham	409	80·3	73·7	70·4	80·2	1·0	1·5	4·6
	6,666	78·9	64·4	63·0	65·6	2·7	3·6	3·9
BUCKINGHAM.								
Amersham	515	42·4	34·0	59·0	56·3	22·3	17·9	24·1
Aylesbury..	554	86·7	83·0	80·1	76·8	4·5	7·2	13·4
Buckingham	260	75·4	67·9	72·7	67·3	8·4	13·6	23·8
Eton	862	83·8	77·6	78·9	80·1	2·8	2·3	2·7
Newport Pagnell	701	68·1	62·5	67·4	64·8	22·5	22·7	23·7
Winslow	166	21·5	28·0	53·0	53·0	52·3	31·5	35·5
Wycombe	1,301	43·7	51·3	40·7	54·3	8·8	21·6	23·8
	4,359	61·8	60·0	65·0	64·9	13·1	15·5	18·6
CAMBRIDGE.								
Cambridge	923	72·0	59·2	67·7	76·7	4·4	3·2	3·0
Caxton and Arrington ..	180	90·8	89·2	81·3	84·4	2·7	9·6	8·3
Chesterton	783	80·7	78·6	84·0	87·6	1·6	3·9	2·7
Ely	494	77·3	76·0	78·7	81·2	3·7	7·4	9·3
Linton	234	86·5	78·5	83·3	85·5	—	1·6	1·3
Newmarket	848	84·0	77·0	74·3	79·4	1·4	3·7	2·7
North Witchford	445	88·3	86·0	81·0	77·5	5·2	9·9	10·6
Whittlesey	204	89·1	82·6	81·2	73·0	0·5	1·2	15·2
Wisbech	891	80·5	71·7	77·2	78·8	0·8	2·6	3·4
	5,002	81·1	74·9	77·2	80·3	2·4	4·5	4·9

* In the Returns for the years 1893–97 the Number of Certificates of Conscientious Objection finally accounted for," but allowance has been made for these in the "Total Unvaccinated."

APP. A, No. 3.

Analysis of Vaccination Officers' Returns, 1893-1900.

IN RESPECTIVE YEARS.

Children not finally accounted for. (3)				Total Unvaccinated. (Col. 2 + Col. 3.)[1]				—
* 1893-97.	1898.	1899.	1900.	* 1893-97.	1898.	1899.	1900.	
								BEDFORD.
34·1	24·0	18·7	11·1	40·6	58·7	31·6	32·8	Ampthill.
66·1	53·4	62·9	71·0	68·8	70·2	64·6	72·1	Bedford.
75·1	59·2	4·0	3·9	75·1	61·0	21·4	28·5	Biggleswade.
73·8	7·4	7·7	7·2	84·9	66·6	36·0	44·6	Leighton Buzzard.
81·7	74·6	43·4	48·9	82·7	80·4	76·7	79·9	Luton.
70·6	54·5	36·4	39·4	73·6	70·9	54·5	59·6	
								BERKS.
3·1	4·5	5·7	5·5	3·1	6·1	8·5	8·2	Abingdon.
4·3	8·7	8·9	7·7	4·5	12·2	15·0	13·0	Bradfield.
8·1	4·0	4·6	3·6	8·3	5·5	6·8	5·4	Easthampstead.
13·9	11·3	10·0	8·7	13·9	13·0	11·2	14·1	Faringdon.
3·1	2·8	3·3	1·1	3·1	5·1	4·2	4·2	Hungerford and Ramsbury.
14·7	9·3	8·2	6·2	15·6	20·5	20·5	19·8	Maidenhead.
7·8	6·9	6·1	3·5	8·0	9·0	9·6	9·0	Newbury.
23·7	59·6	62·0	59·8	23·7	61·1	65·3	61·3	Reading.
3·2	4·9	4·1	3·1	3·3	7·8	6·3	5·5	Wallingford.
7·4	5·9	4·7	6·2	7·7	9·9	7·3	8·6	Wantage.
10·0	13·1	11·0	8·7	10·0	15·1	13·7	11·4	Windsor.
12·7	16·9	18·2	6·4	12·7	17·9	19·7	11·0	Wokingham.
12·2	22·1	22·9	21·2	12·3	24·8	26·5	25·1	
								BUCKINGHAM.
45·1	35·6	13·9	11·7	49·1	57·9	31·8	35·8	Amersham.
4·5	6·0	3·5	2·9	4·5	10·5	10·7	16·3	Aylesbury.
14·3	14·0	5·0	3·1	14·7	23·4	18·6	26·9	Buckingham.
8·1	9·8	8·5	8·2	8·2	12·6	10·8	10·9	Eton.
19·8	4·9	3·6	3·7	22·3	27·4	26·3	26·4	Newport Pagnell.
59·8	6·7	7·1	1·8	69·6	59·0	38·6	37·3	Winslow.
44·4	27·9	19·2	13·9	45·9	36·7	40·8	37·7	Wycombe.
27·1	17·1	10·5	8·4	28·9	30·2	26·0	27·0	
								CAMBRIDGE.
16·8	25·5	15·2	10·9	17·3	29·9	18·4	13·9	Cambridge.
3·2	3·6	2·9	2·2	3·2	6·8	12·5	10·5	Caxton and Arrington.
11·0	11·9	4·3	2·9	11·2	13·5	8·2	5·6	Chesterton.
14·3	9·7	4·5	2·2	14·4	13·4	11·9	11·5	Ely.
6·1	11·3	8·3	8·5	6·1	11·3	9·9	9·8	Linton.
6·8	10·9	12·6	8·1	6·8	12·3	16·3	10·8	Newmarket.
2·7	1·0	2·3	2·0	2·7	6·2	12·2	12·6	North Witchford.
2·2	5·9	7·3	3·4	2·2	6·4	8·5	18·6	Whittlesey.
8·4	14·9	9·0	7·2	8·4	15·7	11·6	10·6	Wisbech.
9·5	12·7	8·5	6·2	9·6	15·1	13·0	11·1	

received in respect of the children born in 1897 has not been included in the Percentages "Not

APP. A, No. 3.

Analysis of Vaccination Officers' Returns, 1893–1900.

—	Number of Births in 1900.	Percentages of Births: Certificates of "Successful Vaccination." (1) 1893–97.	1898.	1899.	1900.	Certificates of "Conscientious Objection." (2) 1898.	1899.	1900.
CHESTER.								
Birkenhead	4,997	86·9	84·2	84·6	85·2	0·2	0·1	0·2
Bucklow	1,893	87·6	84·6	81·4	85·6	0·8	1·5	1·2
Chester	1,477	84·5	78·6	80·2	82·8	0·3	0·7	0·3
Congleton	880	82·5	77·7	78·5	82·4	1·8	1·1	1·4
Macclesfield	1,440	84·1	83·2	84·9	85·8	1·5	1·1	1·0
Nantwich	2,225	80·0	74·3	76·1	79·3	3·1	3·8	3·0
Northwich	1,736	89·4	88·0	88·6	89·2	0·6	0·7	0·7
Runcorn	1,179	81·0	86·9	84·9	85·8	0·8	1·2	0·8
Stockport	4,223	70·0	69·5	72·3	77·0	3·9	2·3	2·2
Tarvin	407	90·6	86·0	87·3	90·9	0·5	0·8	1·0
Wirral	1,188	83·5	82·8	85·6	85·9	0·1	0·4	0·3
	21,645	82·1	80·1	81·0	83·3	1·5	1·3	1·2
CORNWALL.								
Austell, St.	871	73·1	74·4	76·2	83·1	1·6	2·4	3·0
Bodmin	426	83·5	77·7	80·3	84·0	1·2	0·9	1·4
Camelford	180	81·0	85·0	88·8	81·6	1·5	3·6	3·9
Columb Major, St.	379	68·6	72·6	74·2	82·0	0·3	2·1	2·4
Falmouth	538	10·7	13·6	46·5	72·3	4·1	5·3	7·4
Germans, St.	483	80·9	85·7	86·3	87·6	0·2	0·2	0·2
Helston	521	72·4	65·6	70·2	76·2	0·2	2·5	0·8
Launceston	298	85·8	81·9	85·4	81·9	5·7	4·2	9·7
Liskeard	556	75·8	69·8	77·4	80·9	2·2	4·8	7·2
Penzance	1,197	70·3	64·7	75·9	78·4	0·2	0·9	2·5
Redruth	1,286	48·1	40·1	54·1	59·2	0·4	1·0	1·7
Stratton	157	79·6	67·8	67·6	72·0	—	—	—
Truro	817	44·1	66·8	62·3	77·2	2·6	3·7	4·4
	7,709	63·5	62·8	70·3	76·3	1·4	2·3	3·2
CUMBERLAND.								
Alston-with-Garrigill	57	22·9	67·2	68·5	68·4	18·1	17·8	17·6
Bootle	440	80·9	77·0	83·4	83·2	2·3	0·4	0·5
Brampton	162	77·4	70·0	73·1	71·0	0·5	2·8	1·2
Carlisle	1,764	83·2	80·8	85·4	84·9	0·4	1·2	1·0
Cockermouth	2,063	41·2	32·3	41·2	47·5	9·4	13·0	12·8
Longtown	152	86·7	85·8	78·1	85·5	—	1·2	1·3
Penrith	528	86·1	80·8	84·7	85·4	7·9	4·4	5·5
Whitehaven	1,764	85·1	82·8	84·1	85·3	2·6	3·0	3·2
Wigton	521	87·2	79·9	83·1	83·5	3·2	2·3	5·0
	7,451	72·3	67·4	71·5	74·0	4·4	5·5	5·5
DERBY.								
Ashbourne	519	81·3	68·7	69·6	75·3	1·6	2·8	3·3
Bakewell	841	76·5	71·1	76·8	73·2	3·8	6·8	8·3
Belper	2,067	69·2	54·4	61·9	61·4	8·4	5·4	3·7
Chapel-en-le-Frith	713	80·1	76·3	79·5	85·7	2·3	1·3	0·7
Chesterfield	4,672	58·8	47·3	56·4	56·1	0·2	1·9	1·7
Derby	2,935	12·4	15·2	15·5	13·8	1·2	1·2	2·0
Glossop	635	38·9	39·5	56·9	57·5	2·8	20·3	20·0
Hayfield	338	76·6	73·4	79·9	76·6	—	1·2	1·2
Shardlow	1,918	51·1	39·9	50·3	48·1	8·0	4·1	4·0
	14,638	52·2	45·1	51·3	51·0	3·1	3·6	3·5

* In the Returns for the years 1893–97 the Number of Certificates of Conscientious Objection finally accounted for," but allowance has been made for these in the "Total Unvaccinated."

App. A, No. 3.

Analysis of Vaccination Officers' Returns, 1893–1900.

IN RESPECTIVE YEARS.

Children not finally accounted for. (3) 1893–97.*	1898.	1899.	1900.	Total Unvaccinated. (Col. 2 + Col. 3.) 1893–97.*	1898.	1899.	1900.	—
								CHESTER.
2·3	3·7	3·5	3·6	2·3	3·9	3·6	3·8	Birkenhead.
3·5	3·4	3·1	2·5	3·5	4·2	4·6	3·7	Bucklow.
4·2	8·2	5·9	5·1	4·2	8·5	6·6	5·4	Chester.
7·3	11·5	10·1	7·7	7·4	13·3	11·2	9·1	Congleton.
4·9	3·5	3·1	2·9	4·9	5·0	4·2	3·9	Macclesfield.
8·8	10·5	9·0	8·1	8·9	13·6	12·8	11·1	Nantwich.
1·7	1·4	1·0	1·2	1·7	2·0	1·7	1·9	Northwich.
9·2	2·6	2·3	2·9	9·2	3·4	3·5	3·7	Runcorn.
13·9	9·3	9·8	6·6	14·5	13·2	12·1	8·8	Stockport.
1·1	3·4	2·9	0·7	1·1	3·9	3·7	1·7	Tarvin.
7·3	5·4	4·6	4·8	7·3	5·5	5·0	5·1	Wirral.
6·5	5·9	5·4	4·6	6·7	7·4	6·7	5·8	
								CORNWALL.
16·9	11·0	8·0	5·5	17·0	12·6	10·4	8·5	Austell, St.
8 2	12·3	8·0	7·3	8·2	13·5	8·9	8·7	Bodmin.
10·9	8·2	4·1	4·4	11·1	9·7	7·7	8·3	Camelford.
22·8	17·9	12·0	9·2	22·9	18·2	14·1	11·6	Colnmb Major, St.
78·4	69·8	31·2	9·1	79·3	73·9	36·5	16·5	Falmouth.
4·7	6·2	4·2	3·5	4·7	6·4	4·4	3·7	Germans, St.
13·6	19·7	17·2	10·4	13·6	19·9	19·7	11·2	Helston.
5·9	4·2	2·9	2·3	6·7	9·9	7·1	12·0	Launceston.
15·0	18·4	9·4	4·9	15·4	20·6	14·2	12·1	Liskeard.
17·1	18·3	10·5	8·4	17·2	18·5	11·4	10·9	Penzance.
37·0	40·0	29·9	25·0	37·0	40·4	30·9	26·7	Redruth.
10·9	20·9	23·3	15·9	10·9	20·9	23·3	15·9	Stratton.
44·1	18·4	21·9	9·9	44·4	21·0	26·6	14·3	Truro.
25·2	22·7	15·5	10·4	25·4	24·1	17·8	13·6	
								CUMBERLAND.
7·0	1·6	6·8	7·0	7·3	19·7	24·6	24·6	Alston-with-Garrigill.
9·7	11·8	5·5	5·2	10·0	14·1	5·9	5·7	Bootle.
14·2	20·7	16·2	9·9	14·3	21·2	19·0	11·1	Brampton.
6·5	6·5	3·4	2·8	6·5	6·9	4·6	3·8	Carlisle.
45·2	47·0	35·2	28·5	46·9	56·4	48·2	41·3	Cockermouth.
6·2	7·7	6·5	5·9	6·2	7·7	7·7	7·2	Longtown.
4·2	2·3	1·6	0·9	4·7	10·2	6·0	6·4	Penrith.
5·6	4·4	3·1	3·3	5·7	7·0	6·1	6·5	Whitehaven.
4·0	5·2	3·2	1·9	4·3	8·4	5·5	6·9	Wigton.
17·0	17·4	12·8	10·2	17·6	21·8	18·3	15·7	
								DERBY.
10·5	20·7	17·0	13·3	10·7	22·3	19·8	16·6	Ashbourne.
14·0	15·1	8·7	10·3	14·3	18·9	15·5	18·6	Bakewell.
18·2	25·1	20·9	24·8	19·9	33·5	26·3	28·5	Belper.
11·1	11·8	8·7	5·5	11·2	14·1	10·0	6·2	Chapel-en-le-Frith.
28·5	37·9	28·3	27·5	28·5	38·1	30·2	29·2	Chesterfield.
73·5	68·4	66·7	69·4	73·6	69·6	67·9	71·4	Derby.
51·2	43·2	12·9	13·9	51·2	46·0	33·2	33·9	Glossop.
13·3	16·0	10·1	11·2	13·4	16·0	11·3	12·4	Hayfield.
37·7	39·9	32·9	35·9	38·9	47·9	37·0	39·9	Shardlow.
35·6	38·7	32·1	33·1	36·1	41·8	35·7	36·6	

received in respect of the children born in 1897 has not been included in the Percentages "Not

App. A, No. 3.

Analysis of Vaccination Officers' Returns, 1893-1900.

—	Number of Births in 1900.	Percentages of Births						
		Certificates of "Successful Vaccination." (1)				Certificates of "Conscientious Objection." (2)		
		1893-97.	1898.	1899.	1900.	1898.	1899.	1900.
DEVON.								
Axminster	326	86·2	85·3	84·7	87·7	1·4	0·6	3·4
Barnstaple	978	83·4	73·5	78·8	78·7	3·5	4·2	7·1
Bideford	543	86·2	82·8	79·2	82·3	2·1	3·9	6·8
Crediton	348	89·2	92·9	93·3	90·2	0·3	0·5	1·7
Devonport	1,935	74·0	49·2	57·9	69·8	0·4	0·3	0·3
East Stonehouse	439	65·2	58·5	78·2	80·4	—	0·4	0·7
Exeter	831	74·5	72·5	70·0	77·0	1·7	4·4	3·6
Holsworthy	231	90·0	85·3	84·1	85·7	2·0	2·6	0·9
Honiton	412	90·0	88·7	87·8	90·0	2·1	1·5	1·5
Kingsbridge	339	88·4	89·0	86·6	90·3	1·7	2·2	2·7
Newton Abbot	1,555	88·6	83·6	81·3	82·2	1·8	2·7	3·3
Okehampton	358	86·8	80·9	82·0	87·7	3·1	1·7	1·1
Plymouth	2,870	68·8	53·9	55·8	67·6	0·6	0·4	0·8
Plympton St. Mary	491	80·2	68·0	85·1	90·3	0·8	0·2	—
South Molton	318	89·2	89·5	88·9	80·5	1·2	—	0·9
Tavistock	604	89·2	85·4	86·0	85·1	4·2	4·9	5·1
Thomas, St.	1,194	82·6	79·4	81·5	85·0	0·7	1·2	2·6
Tiverton	645	85·2	79·2	84·0	83·7	2·1	2·0	2·2
Torrington	298	90·4	86·0	87·2	85·6	1·3	2·4	1·7
Totnes	940	91·0	87·2	89·4	89·7	0·9	0·5	1·0
	15,658	81·4	72·5	74·8	79·4	1·4	1·6	2·2
DORSET.								
Beaminster	214	88·5	89·9	89·6	88·3	0·8	0·4	0·5
Blandford	256	76·9	71·8	73·5	75·8	4·6	6·8	6·6
Bridport	258	90·5	87·6	86·6	90·3	1·0	1·6	1·6
Cerne	127	90·5	83·6	87·1	85·8	6·6	2·6	5·5
Dorchester	402	83·9	78·8	75·2	79·1	1·6	3·2	1·2
Poole	873	66·7	63·2	71·5	72·6	8·6	6·0	7·0
Shaftesbury	277	81·1	82·1	85·3	84·5	4·6	3·5	4·7
Sherborne	264	84·1	84·2	83·9	86·4	1·2	—	0·4
Sturminster	194	88·9	88·9	85·0	90·7	0·9	1·4	2·6
Wareham and Purbeck	360	89·7	86·8	87·2	90·3	1·2	3·7	3·6
Weymouth	941	56·8	36·1	56·8	62·4	57·2	3·4	8·6
Wimborne and Cranborne	358	79·6	86·9	85·4	91·1	1·4	1·6	1·4
	4,524	76·6	70·9	78·0	78·5	13·9	3·4	4·7
DURHAM.								
Auckland	3,211	64·8	56·4	65·6	68·1	6·5	6·4	7·6
Chester-le-Street	2,361	79·2	73·2	75·6	75·3	0·7	0·6	1·3
Darlington	1,560	35·4	36·4	54·9	64·6	1·3	2·3	2·5
Durham	2,261	79·0	68·5	72·0	75·4	0·6	4·1	4·3
Easington	1,862	84·7	83·4	83·5	85·9	0·7	1·2	0·5
Gateshead	6,350	48·3	42·0	49·6	48·0	11·0	6·5	7·3
Hartlepool	3,066	81·0	77·1	80·0	77·7	1·9	1·6	1·5
Houghton-le-Spring	1,555	83·6	75·0	76·3	82·4	0·5	0·5	—
Lanchester	2,953	72·6	60·9	69·3	68·7	1·9	4·3	6·1
Sedgefield	746	85·2	83·3	84·7	83·6	0·7	1·3	1·7
South Shields	5,915	69·9	63·7	62·9	72·0	0·7	0·6	0·6
Stockton	2,224	81·6	79·0	77·2	78·9	1·1	3·0	2·0
Sunderland	6,651	74·6	68·6	72·4	71·7	0·4	0·5	0·7
Teesdale	504	60·6	59·7	73·8	81·9	4·0	3·2	2·4
Weardale	460	83·8	82·0	84·1	80·6	3·1	4·2	4·8
	41,669	70·2	63·9	66·2	76·1	2·9	2·8	3·1

* In the Returns for the years 1893-97 the Number of Certificates of Conscientious Objection finally accounted for," but allowance has been made for these in the "Total Unvaccinated."

APP. A, No. 3.

Analysis of Vaccination Officers' Returns, 1893-1900.

IN RESPECTIVE YEARS.

Children not finally accounted for. (3)				Total Unvaccinated. (Col. 2 + Col. 3.)				—
* 1893-97.	1898.	1899.	1900.	* 1893-97.	1898.	1899.	1900.	
								DEVON.
6·0	5·1	6·5	3·4	6·3	6·5	7·1	6·8	Axminster.
7·1	12·8	6·6	5·9	7·5	16·3	10·8	13·0	Barnstaple.
4·5	5·5	6·3	3·9	5·4	7·6	10·2	10·7	Bideford.
3·4	1·0	1·0	1·4	3·4	1·3	1·5	3·1	Crediton.
15·4	37·8	28·7	16·6	15·4	38·2	29·0	16·9	Devonport.
21·4	27·2	8·2	6·6	21·4	27·2	8·6	7·3	East Stonehouse.
13·6	14·9	9·4	8·2	13·6	16·6	13·8	11·8	Exeter.
2·9	4·1	3·0	3·5	2·9	6·1	5·6	4·4	Holsworthy.
2·9	1·8	1·9	1·9	2·9	3·9	3·4	3·4	Honiton.
3·3	4·3	2·8	2·7	3·3	6·0	5·0	5·4	Kingsbridge.
3·1	5·2	4·2	5·3	3·1	7·0	6·9	8·6	Newton Abbot.
6·5	8·7	7·5	6·7	6·7	11·8	9·2	7·8	Okehampton.
18·0	33·0	27·0	18·2	18·1	33·6	27·4	19·0	Plymouth.
11·3	19·4	4·7	3·6	11·4	20·2	4·9	3·6	Plympton St. Mary.
3·5	2·9	1·9	8·5	3·6	4·1	1·9	9·4	South Molton.
3·0	2·4	1·7	2·2	3·2	6·6	6·6	7·3	Tavistock.
8·4	10·6	7·5	6·2	8·4	11·3	8·7	8·8	Thomas, St.
5·7	9·6	3·6	5·7	5·7	11·7	5·6	7·9	Tiverton.
4·2	5·6	3·8	3·4	4·3	6·9	6·2	5·1	Torrington.
1·7	2·7	1·9	2·1	1·8	3·6	2·4	3·1	Totnes.
9·0	16·0	11·8	8·7	9·1	17·4	13·4	10·9	
								DORSET.
4·7	4·2	2·8	3·3	4·7	5·0	3·2	3·8	Beaminster.
14·7	18·2	11·7	9·0	14·9	22·8	18·5	15·6	Blandford.
1·7	3·6	2·3	1·9	1·7	4·6	3·9	3·5	Bridport.
2·8	2·5	2·6	4·7	3·3	9·1	5·2	10·2	Cerne.
8·0	13·8	12·8	11·4	8·0	15·4	16·0	12·6	Dorchester.
23·5	17·8	11·5	10·8	23·9	26·4	17·5	17·8	Poole.
10·3	8·3	5·8	6·1	10·7	12·9	9·3	10·8	Shaftesbury.
8·8	6·9	8·2	8·0	8·8	8·1	8·2	8·4	Sherborne.
3·1	4·4	3·3	3·1	3·2	5·3	4·7	5·7	Sturminster.
3·6	5·2	2·2	1·4	3·6	6·4	5·9	5·0	Wareham and Purbeck.
35·8	—	29·3	20·1	35·8	57·2	33·7	28·7	Weymouth.
13·5	6·7	4·4	2·8	13·6	8·1	6·0	4·2	Wimborne and Cranborne
15·5	8·2	11·7	9·5	15·6	23·1	15·1	14·2	
								DURHAM.
21·6	20·9	12·3	10·5	22·2	27·4	18·7	18·1	Auckland.
7·7	11·1	8·3	7·8	7·7	11·8	8·9	9·1	Chester-le-Street.
51·8	48·3	30·1	19·7	51·9	49·6	32·4	22·2	Darlington.
9·0	16·4	9·4	6·4	9·0	17·0	13·5	10·7	Durham.
3·4	4·1	3·1	2·4	3·4	4·8	4·3	2·9	Easington.
36·2	32·1	29·6	32·0	37·8	43·1	36·1	39·3	Gateshead.
8·4	8·2	4·7	9·0	8·4	10·1	6·3	10·5	Hartlepool.
3·6	6·3	6·5	5·7	3·6	6·8	7·0	5·7	Houghton-le-Spring
15·2	20·4	12·6	11·8	15·3	22·3	16·9	17·9	Lanchester.
3·1	4·4	2·2	3·1	3·1	5·1	3·5	4·8	Sedgefield.
18·1	22·0	21·8	15·1	18·1	22·7	22·4	15·7	South Shields.
7·1	6·9	6·4	5·8	7·1	8·0	9·4	7·8	Stockton.
13·1	15·3	12·3	13·6	13·1	15·7	12·8	14·3	Sunderland.
27·7	23·8	9·6	6·9	28·4	27·8	12·8	9·3	Teesdale.
5·7	3·3	3·2	3·0	6·1	6·4	7·4	7·8	Weardale.
17·2	18·6	14·8	13·8	17·5	21·5	17·6	16·9	

received in respect of the children born in 1897 has not been included in the Percentages "Not

APP. A, No. 3.

Analysis of Vaccination Officers' Returns, 1893–1900

—	Number of Births in 1900.	Percentages of Births: Certificates of "Successful Vaccination." (1) 1893–97.	1898.	1899.	1900.	Certificates of "Conscientious Objection." (2) 1898.	1899.	1900.
ESSEX.								
Billericay	483	83·0	78·2	76·6	80·7	2·8	4·4	3·5
Braintree	586	84·9	69·9	70·0	79·8	1·7	2·1	3·2
Chelmsford	821	85·4	83·0	84·8	86·7	3·2	4·5	2·8
Colchester	1,001	70·8	47·8	45·1	62·5	1·8	3·2	3·6
Dunmow	376	88·0	82·7	84·1	82·2	3·5	2·5	3·2
Epping	719	85·2	80·3	79·0	84·7	1·8	3·3	2·2
Halstead	[illegible]	87·3	75·3	79·4	77·9	8·0	8·6	10·7
Lexden and Winstree.. ..	503	88·4	82·5	84·5	85·1	5·3	4·8	5·6
Maldon	561	87·8	76·7	76·2	79·0	5·4	8·9	8·6
Ongar	211	82·6	76·7	84·0	82·5	—	—	—
Orsett	979	49·1	36·8	52·0	52·6	37·2	18·1	25·0
Rochford	1,379	62·5	42·4	61·9	63·2	8·2	8·3	12·3
Romford	2,806	68·8	61·0	65·3	66·7	1·5	1·6	1·7
Saffron Walden	336	86·8	82·1	87·8	84·8	1·1	1·9	2·1
Tendring	1,216	83·2	68·5	68·9	72·8	4·3	5·2	5·1
West Ham	18,816	65·0	45·0	55·9	55·9	1·1	1·4	1·5
	31,159	69·9	53·0	61·2	62·4	3·2	3·0	3·4
GLOUCESTER.								
Barton Regis	410	68·4	70·7	70·9	70·2	0·3	0·8	3·7
Bristol	9,089	60·0	40·6	52·8	57·4	2·9	1·7	2·4
Cheltenham	1,155	42·7	28·0	48·9	52·0	9·0	15·9	19·5
Chipping Sodbury	463	71·9	60·8	70·5	69·3	1·7	0·4	3·7
Cirencester	445	77·7	78·6	82·3	85·2	6·8	4·0	2·5
Dursley	265	48·3	58·8	59·5	63·9	11·1	11·7	20·4
Gloucester	1,586	27·0	25·4	38·4	33·3	29·6	14·0	20·8
Newent	202	76·8	82·7	80·4	80·7	4·7	4·6	7·9
Northleach	171	85·8	87·1	81·3	81·9	2·0	5·3	5·8
Stow-on-the-Wold	178	76·1	74·6	77·0	79·2	8·8	10·5	11·2
Stroud	825	32·6	39·1	44·9	38·2	31·4	18·1	19·3
Tetbury	144	53·3	52·6	75·9	69·4	20·7	13·1	16·7
Tewkesbury	352	24·4	23·6	25·1	23·9	32·8	20·4	23·3
Thornbury	414	84·3	81·1	81·0	78·5	7·0	7·9	10·9
Westbury-on-Severn	681	13·3	32·9	46·5	42·4	44·6	27·1	39·2
Wheatenhurst	135	41·0	57·3	46·0	51·1	8·7	—	14·8
Winchcomb	215	78·4	70·3	68·8	67·9	—	19·4	23·3
	16,720	56·3	43·1	53·7	55·5	10·2	6·9	9·4
HEREFORD.								
Bromyard..	239	80·7	69·5	77·3	84·1	2·3	0·7	1·7
Dore	165	77·1	73·5	78·7	78·8	1·0	4·7	6·1
Hereford	784	83·1	77·1	78·0	80·2	1·9	2·0	2·9
Kington	263	81·8	74·6	80·8	88·2	0·4	3·2	0·8
Ledbury	325	86·4	80·4	84·9	84·0	0·6	1·4	2·8
Leominster	304	85·3	79·7	84·2	84·9	1·9	1·4	3·9
Ross..	390	80·2	74·6	80·3	81·5	7·6	4·6	7·2
Weobley	152	84·1	72·4	88·7	90·1	0·6	0·7	0·7
	2,622	82·6	76·0	80·8	83·1	2·3	2·4	3·4

* In the Returns for the years 1893-97 the Number of Certificates of Conscientious Objection finally accounted for," but allowance has been made for these in the "Total Unvaccinated."

App. A, No. 3.

Analysis of Vaccination Officers' Returns. 1893–1900.

IN RESPECTIVE YEARS.

Children not finally accounted for. (3)				Total Unvaccinated. (Col. 2 + Col. 3.)				—
* 1893–97.	1898.	1899.	1900.	* 1893–97.	1896.	1899.	1900.	
								ESSEX.
9·5	10·7	8·1	5·6	9·6	13·5	12·5	9·1	Billericay.
7·2	20·2	20·6	11·1	7·2	21·9	22·7	14·3	Braintree.
7·2	6·0	3·7	3·2	7·3	9·2	8·2	6·0	Chelmsford.
19·4	40·0	41·1	23·5	19·6	41·8	44·3	27·1	Colchester.
5·3	7·3	6·1	8·2	5·4	10·8	8·6	11·4	Dunmow.
7·1	9·1	6·8	5·7	7·2	10·9	10·1	7·9	Epping.
5·5	7·2	5·2	4·6	5·9	15·2	13·8	15·3	Halstead.
4·8	5·6	5·2	3·6	4·8	10·9	10·0	9·2	Lexden and Winstree.
5·0	9·7	6·7	7·5	5·1	15·1	15·6	16·1	Maldon.
8·9	16·9	5·3	9·0	8·9	16·9	5·3	9·0	Ongar.
34·1	14·7	19·5	11·5	40·4	51·9	37·6	36·5	Orsett.
27·0	37·4	18·9	12·7	27·8	45·6	27·2	25·0	Rochford.
22·4	25·9	21·1	18·4	22·5	27·4	22·7	20·1	Romford.
6·5	6·7	2·8	3·3	6·6	7·8	4·7	5·4	Saffron Walden.
7·6	18·4	15·6	10·7	7·8	22·7	20·8	15·8	Tendring.
24·7	42·9	29·7	30·8	24·7	44·0	31·1	32·3	West Ham.
20·3	33·3	24·1	23·3	20·6	36·5	27·1	26·7	
								GLOUCESTER.
20·6	20·1	17·1	16·8	20·9	20·4	17·9	20·5	Barton Regis.
27·8	44·6	32·2	29·0	28·0	47·5	33·9	31·4	Bristol.
43·7	50·6	23·0	19·6	45·1	59·6	38·9	39·1	Cheltenham.
21·0	27·7	18·7	18·1	21·0	29·4	19·1	21·8	Chipping Sodbury.
12·8	6·2	3·1	3·4	13·0	13·0	7·1	5·9	Cirencester.
43·7	20·1	19·7	10·6	45·6	31·2	31·4	31·0	Dursley.
54·2	29·7	34·6	36·3	59·7	59·3	48·6	57·1	Gloucester.
15·5	7·9	8·8	5·4	15·9	12·6	13·4	13·3	Newent.
6·8	5·9	2·9	3·5	6·9	7·9	8·2	9·3	Northleach.
13·4	9·8	3·7	2·2	14·3	18·6	14·2	13·4	Stow-on-the-Wold.
52·0	20·3	27·7	34·9	58·6	51·7	45·8	54·2	Stroud.
32·5	16·6	2·9	4·9	35·6	37·3	16·0	21·6	Tetbury.
56·2	32·2	43·7	43·7	63·6	65·0	64·1	67·0	Tewkesbury.
8·2	7·0	4·9	3·9	8·5	14·0	12·8	14·8	Thornbury.
70·9	13·7	17·5	10·6	78·3	58·3	44·6	49·8	Westbury-on-Severn.
48·1	26·0	52·4	25·2	49·8	34·7	52·4	40·0	Wheatenhurst.
12·3	21·1	7·6	1·9	13·2	21·1	27·0	25·2	Winchcomb.
31·3	35·4	27·5	25·3	32·6	45·6	34·4	34·7	
								HEREFORD.
11·6	18·4	12·3	7·5	12·0	20·7	13·0	9·2	Bromyard.
12·6	19·0	9·4	6·7	12·6	20·0	14·1	12·8	Dore.
7·6	9·1	9·5	7·4	7·7	11·0	11·5	10·3	Hereford.
9·3	18·2	6·0	2·3	9·4	18·6	9·2	3·1	Kington.
6·0	11·6	6·5	3·7	6·0	12·2	7·9	6·5	Ledbury.
6·4	9·2	3·7	3·0	6·4	11·1	5·1	6·9	Leominster.
10·1	6·9	5·8	5·4	10·7	14·5	10·4	12·6	Ross.
8·9	19·4	4·7	1·3	8·9	20·0	5·4	2·0	Weobley.
8·6	12·1	7·6	5·2	8·7	14·4	10·0	8·6	

received in respect of the children born in 1897 has not been included in the Percentages * Not

App. A, No. 3.

Analysis of Vaccination Officers' Returns, 1898–1900.

—	Number of Births in 1900.	Percentages of Births: Certificates of "Successful Vaccination." (1)				Certificates of "Conscientious Objection." (2)		
		1893–97.	1898.	1899.	1900.	1898.	1899.	1900.
HERTFORD.								
Albans, St.	741	22·5	7·8	46·3	47·2	25·4	14·8	26·6
Barnet	1,409	72·1	65·2	70·5	76·4	3·2	3·6	3·3
Berkhampstead	363	77·1	67·5	74·1	69·2	9·5	10·2	14·9
Bishop Stortford	484	86·9	79·6	80·0	81·6	1·9	4·7	4·1
Buntingford	110	86·2	83·9	89·8	88·2	0·9	0·9	2·7
Hatfield	199	85·5	87·6	88·3	88·9	2·2	1·5	2·0
Hemel Hempstead	434	62·6	48·1	53·5	68·7	6·6	7·5	7·4
Hertford	405	86·9	85·6	83·2	86·4	2·6	3·8	2·0
Hitchin	686	87·2	82·9	86·0	84·0	5·5	3·3	5·0
Royston	345	87·1	81·5	83·8	84·9	4·8	2·3	3·5
Ware	488	86·0	77·1	85·6	84·6	2·2	1·5	2·3
Watford	1,318	57·6	54·3	73·3	70·0	1·8	3·9	4·9
Welwyn	59	89·1	68·4	85·5	84·7	5·3	1·4	—
	7,041	70·6	62·9	73·1	74·5	5·9	5·2	6·9
HUNTINGDON.								
Huntingdon	477	87·0	84·9	80·3	78·6	2·7	5·7	5·9
Ives, St.	350	88·6	85·7	84·9	89·7	2·8	3·2	3·7
Neots, St.	332	79·4	76·9	81·6	79·8	3·6	3·9	5·4
	1,159	85·3	82·7	82·1	82·3	3·0	4·4	5·1
KENT (Extra-Metropolitan).								
Ashford, East	313	88·3	81·0	84·1	85·9	7·5	5·5	5·1
Ashford, West	506	80·2	76·2	77·0	74·9	3·9	7·6	11·7
Blean	623	84·4	78·4	77·1	82·2	4·1	4·2	3·7
Bridge	254	84·2	77·9	81·8	83·5	7·1	0·7	0·8
Bromley	1,946	68·4	68·6	75·3	84·0	1·4	2·8	1·6
Canterbury	470	80·6	62·7	78·7	83·8	0·6	1·4	1·7
Cranbrook	278	83·8	80·7	77·6	78·4	4·5	2·4	4·0
Dartford	2,727	81·6	77·2	79·7	81·9	2·5	3·7	4·3
Dover	1,306	66·5	55·5	80·4	82·7	0·2	1·7	2·1
Eastry	720	88·4	83·1	86·4	86·8	1·2	2·2	1·7
Elham	1,225	81·9	77·2	78·2	78·0	0·5	3·4	3·3
Faversham	768	89·1	88·5	84·9	83·3	1·3	2·2	3·3
Gravesend and Milton ..	663	70·7	47·5	49·8	51·9	1·2	0·6	0·6
Hollingbourn	302	82·9	79·2	81·5	89·1	0·3	0·7	1·0
Hoo	127	88·3	86·1	80·4	86·6	—	—	—
Maidstone	1,218	59·7	59·3	64·1	64·9	2·6	4·9	4·6
Malling	712	87·0	84·0	81·9	85·1	1·4	1·4	2·4
Medway	2,629	82·2	79·6	79·5	78·3	0·7	1·6	2·9
Milton	835	76·8	76·9	81·7	82·0	0·2	3·4	6·6
Romney Marsh	168	89·5	86·2	87·5	82·3	2·4	0·7	3·2
Sevenoaks	694	82·5	77·5	75·8	80·2	1·2	1·7	2·9
Sheppey	543	80·3	64·3	74·2	77·7	2·7	1·5	0·7
Strood	1,279	83·3	79·9	79·3	84·3	2·6	3·0	4·0
Tenterden	215	85·1	78·8	77·6	80·0	2·3	5·0	4·2
Thanet, Isle of	1,536	84·2	67·9	70·4	75·6	9·2	9·4	9·6
Tonbridge	1,515	48·9	47·7	59·7	61·1	24·0	18·8	16·7
	23,562	77·2	71·9	75·9	78·4	3·7	4·2	4·6

* In the Returns for the years 1893–97 the Number of Certificates of Conscientious Objection finally accounted for," but allowance has been made for these in the "Total Unvaccinated."

IN RESPECTIVE YEARS.

App. A, No. 3

Analysis of Vaccination Officers' Returns, 1893-1900.

Children not finally accounted for. (3)				Total Unvaccinated. (Col. 2 + Col. 3.)				
*1893-97.	1898.	1899.	1900.	*1893 97.	1898.	1899.	1900.	
								HERTFORD
62·3	56·8	29·3	17·5	66·5	84·2	44·1	44·1	Albans, St.
19·7	21·4	16·4	12·6	19·9	24·6	20·0	15·9	Barnet.
11·5	12·7	7·4	6·1	12·6	22·2	17·6	21·0	Berkhampstead.
5·8	9·0	5·8	6·2	6·0	10·9	10·5	10·3	Bishop Stortford.
5·5	8·5	1·9	3·6	5·5	9·4	2·8	6·3	Buntingford.
6·1	4·3	3·4	2·0	6·3	6·5	4·9	4·0	Hatfield.
25·5	36·0	26·9	15·2	27·3	41·6	34·4	22·6	Hemel Hempstead.
6·3	4·6	3·1	4·2	6·3	7·2	6·9	6·2	Hertford.
4·2	3·6	4·3	2·5	4·2	9·1	7·6	7·5	Hitchin.
5·0	5·1	5·5	2·9	5·1	9·9	7·8	6·4	Royston.
6·9	10·0	5·3	4·9	6·9	12·2	6·8	7·2	Ware.
33·9	33·6	12·8	15·6	34·0	35·4	16·7	20·5	Watford.
5·6	8·8	7·2	6·8	5·6	14·1	8·6	6·8	Welwyn.
20·3	21·8	12·6	10·1	21·2	27·7	17·8	17·0	
								HUNTINGDON.
3·9	5·3	5·1	3·4	3·9	8·0	10·8	9·3	Huntingdon.
2·6	2·5	3·0	0·3	2·7	5·3	6·2	4·0	Ives, St.
12·7	10·2	4·5	5·7	12·8	13·8	8·4	11·1	Neots, St.
6·0	5·9	4·3	3·1	6·0	8·9	8·7	8·2	
								KENT (EXTRA-METROPOLITAN).
4·2	5·1	3·4	2·6	4·3	12·6	8·9	7·7	Ashford, East.
11·2	10·5	5·8	5·7	11·9	14·4	13·4	17·4	Ashford, West.
6·6	8·0	6·9	5·6	6·7	12·1	11·1	9·3	Blean.
8·0	7·8	6·2	7·9	8·1	14·9	6·9	8·7	Bridge.
20·7	19·1	10·6	6·2	20·8	20·5	13·4	7·8	Bromley.
10·7	22·0	8·4	4·3	10·7	22·6	9·8	6·0	Canterbury.
9·0	11·7	9·1	10·4	9·3	16·2	11·5	14·4	Cranbrook.
8·6	7·6	4·3	3·8	8·7	10·1	8·0	8·1	Dartford.
23·4	31·8	6·0	4·6	23·4	32·0	7·7	6·7	Dover.
3·7	5·4	2·8	2·5	4·2	6·6	5·0	4·2	Eastry.
9·3	11·4	7·7	8·2	9·3	11·9	11·1	11·5	Elham.
2·2	2·2	2·2	1·8	2·2	3·5	4·4	5·1	Faversham.
18·4	38·9	35·6	36·2	18·5	40·1	36·2	36·8	Gravesend and Milton.
7·3	11·4	11·6	3·0	7·3	11·7	12·3	4·0	Hollingbourn.
2·6	5·0	7·5	3·1	2·6	5·0	7·5	3·1	Hoo.
30·1	28·1	22·5	22·5	30·3	30·7	27·4	27·1	Maidstone.
4·7	5·2	3·7	3·8	4·7	6·6	5·1	6·2	Malling.
8·4	8·8	7·3	7·2	8·4	9·5	8·9	10·1	Medway.
13·8	10·7	3·4	2·6	13·8	10·9	6·8	9·2	Milton.
2·5	7·2	2·0	8·2	2·6	9·6	2·7	11·4	Romney Marsh.
9·8	16·0	11·5	6·6	9·8	17·2	13·2	9·5	Sevenoaks.
9·0	19·1	11·6	10·7	9·1	21·8	13·1	11·4	Sheppey.
5·9	6·3	4·6	3·3	6·0	8·9	7·6	7·3	Strood.
6·5	10·4	8·5	5·6	6·6	12·7	13·5	9·8	Tenterden.
6·1	10·1	9·8	5·3	6·9	19·3	19·2	14·9	Thanet, Isle of.
38·0	17·5	12·5	16·1	41·1	41·5	31·3	32·8	Tonbridge.
13·1	13·7	8·8	7·6	13·4	17·4	13·0	12·2	

received in respect of the children born in 1897 has not been included in the Percentages "Not

—	Number of Births in 1900.	PERCENTAGES OF BIRTHS						
		Certificates of "Successful Vaccination." (1)				Certificates of "Conscientious Objection." (2)		
		1893-97.	1898.	1899.	1900.	1898.	1899.	1900.
LANCASTER.								
Ashton-under-Lyne	4,869	25·2	37·5	57·3	68·8	21·6	8·2	8·0
Barrow-in-Furness	1,811	86·1	84·0	85·2	86·1	1·5	0·9	0·6
Barton-upon-Irwell	2 970	64·3	58·6	65·2	64·3	0·8	1·4	1·7
Blackburn	6,040	74·4	67·3	76·1	79·3	5·8	3·2	3·1
Bolton	7,454	81·0	78·0	85·2	86·5	0·4	0·6	0·7
Burnley	5,599	26·9	20·1	41·1	44·4	28·9	14·0	15·4
Bury	3,489	21·1	36·4	55·7	56·6	35·6	14·7	18·5
Chorley	1,713	76·3	69·8	76·4	82·6	0·6	0·2	0·7
Chorlton	10,210	70·5	56·8	60·3	63·4	0·5	0·6	0·6
Clitheroe	520	76·2	76·0	77·0	70·8	3·8	3·0	3·1
Fylde, The	2,550	70·9	54·3	64·5	65·8	2·0	3·0	2·9
Garstang	282	86·5	87·4	90·8	90·1	3·9	0·3	4·2
Haslingden	2,889	61·2	51·3	67·6	73·5	26·5	11·4	11·6
Lancaster	1,796	83·1	74·9	76·4	77·6	1·5	0·6	1·0
Leigh	3,023	76·9	73·8	79·7	82·3	0·4	1·0	0·7
Liverpool	5,174	82·5	81·3	75·3	79·2	0·1	0·1	0·0
Lunesdale..	177	80·5	67·2	78·6	78·0	—	—	1·1
Manchester	4,590	83·8	69·9	63·3	68·5	0·4	0·2	0·2
Oldham	5,813	3·7	12·2	46·5	43·3	23·7	19·9	27·5
Ormskirk	2,607	83·0	82·0	82·2	85·9	1·4	1·2	0·9
Prescot	5,268	80·6	81·4	82·2	84·5	0·6	0·5	0·3
Preston	4,434	64·2	60·0	66·1	70·4	1·1	0·7	0·8
Prestwich..	6,053	71·6	67·0	73·4	78·7	0·4	0·8	0·8
Rochdale	2,900	20·1	21·2	49·2	51·8	49·7	15·6	14·6
Salford	7,604	65·8	60·3	67·5	71·6	0·7	1·0	0·9
Todmorden	890	17·1	37·8	71·0	69·2	41·4	12·1	15·3
Toxteth Park	4,060	75·4	67·7	67·4	74·4	0·4	0·1	0·2
Ulverston	1,153	87·6	87·1	88·1	90·2	0·9	0·3	0·5
Warrington	3,571	81·6	73·5	73·6	77·1	0·6	0·7	0·5
West Derby	17,496	81·6	78·1	76·3	78·7	0·2	0·1	0·2
Wigan	7,055	72·1	74·6	77·7	78·7	2·2	1·1	1·1
	134,040	65·4	62·1	69·2	71·9	6·9	3·5	3·9
LEICESTER.								
Ashby-de-la-Zouch	1,476	22·3	22·7	47·0	45·9	30·2	18·2	17·1
Barrow-on-Soar	702	2·6	7·6	15·2	18·9	63·5	36·0	43·5
Billesdon	132	74·0	68·9	61·6	68·9	12·8	14·2	9·9
Blaby	685	3·7	7·7	27·0	21·6	19·5	32·5	52·5
Hinckley	772	9·1	11·9	17·2	34·4	48·0	22·6	33·0
Leicester	6,206	1·3	1·4	3·5	5·1	17·5	2·7	9·6
Loughborough	963	6·2	11·2	22·5	22·0	58·6	43·7	43·9
Lutterworth	267	50·2	26·9	68·0	64·8	15·3	8·7	21·3
Market Bosworth	565	39·9	24·4	37·2	37·0	43·0	39·3	41·4
Market Harborough	476	8·1†	5·9	27·3	50·0	—	11·6	37·6
Melton Mowbray	587	14·4	27·0	56·0	63·0	50·3	22·8	22·5
	12,831	9·2	9·5	19·0	22·1	26·4	15·3	21·9
LINCOLN.								
Boston	1,072	58·3	50·1	66·0	66·3	12·6	14·4	22·1
Bourne	473	72·7	61·3	62·4	75·3	8·4	2·0	1·7
Caistor	389	79·4	69·4	65·4	73·3	13·6	20·6	15·4
Gainsborough	917	24·2	23·0	43·9	39·8	47·6	24·2	26·6
Glanford Brigg	1,350	56·7	36·2	56·3	53·5	42·9	21·8	28·9
Grantham..	876	80·1	60·4	73·8	77·5	9·1	6·5	8·0

* In the Returns for the years 1893-97 the Number of Certificates of Conscientious Objection finally accounted for," but allowance has been made for these in the "Total Unvaccinated."

† Market Harborough, vaccinations given for 1893 and 1897 only.

IN RESPECTIVE YEARS.

Children not finally accounted for. (3)				Total Unvaccinated. (Col. 2 + Col. 3.)				
* 1893-97.	1898.	1899.	1900.	* 1893-97.	1898.	1899.	1900.	—
								LANCASTER.
54·6	23·3	16·8	19·3	58·6	44·8	25·0	27·3	Ashton-under-Lyne.
4·4	2·9	2·3	2·8	4·5	4·4	3·2	3·4	Barrow-in-Furness.
23·5	27·0	19·6	21·6	23·6	27·8	21·0	23·3	Barton-upon-Irwell.
12·2	11·0	6·8	5·2	12·6	16·8	10·0	8·3	Blackburn.
7·4	7·8	2·5	2·2	7·4	8·2	3·1	2·9	Bolton.
55·3	35·1	28·7	25·9	59·2	64·0	42·7	41·3	Burnley.
53·7	13·6	15·7	13·5	60·3	49·2	30·4	32·0	Bury.
11·3	16·6	8·9	5·6	11·3	17·2	9·1	6·3	Chorley.
16·2	26·7	23·4	22·9	16·2	27·2	24·0	23·5	Chorlton.
13·4	7·9	10·9	17·9	13·8	11·7	13·9	21·0	Clitheroe.
16·4	28·5	20·2	18·7	16·5	30·5	23·2	21·6	Fylde, The.
4·4	1·6	2·7	1·9	4·6	5·5	3·0	6·1	Garstang.
22·9	9·3	9·1	5·6	26·6	35·8	20·5	17·2	Haslingden.
6·5	9·2	9·1	8·4	6·6	10·7	9·7	9·4	Lancaster.
11·7	11·3	5·6	4·4	11·7	11·7	6·6	5·1	Leigh.
4·1	5·3	7·6	5·6	4·1	5·4	7·7	5·6	Liverpool.
13·3	23·7	10·7	10·2	13·4	23·7	10·7	11·3	Lunesdale.
3·9	14·6	19·1	15·9	3·9	15·0	19·3	16·1	Manchester.
70·6	46·8	18·5	15·4	79·1	70·5	38·4	42·9	Oldham.
5·9	6·0	3·7	2·8	6·0	7·4	4·9	3·7	Ormskirk.
7·2	6·1	5·2	4·4	7·2	6·7	5·7	4·7	Prescot.
18·6	21·9	14·2	12·1	18·7	23·0	14·9	12·9	Preston.
18·3	19·7	12·8	9·4	18·3	20·1	13·6	10·2	Prestwich.
56·4	17·2	20·7	22·0	65·6	66·9	36·3	36·6	Rochdale.
19·0	23·0	15·4	12·9	19·0	23·7	16·4	13·8	Salford.
62·4	8·9	6·6	6·9	70·5	50·3	18·7	22·2	Todmorden.
12·0	18·8	17·0	11·5	12·0	19·2	17·1	11·7	Toxteth Park.
4·1	3·4	0·8	2·1	4·1	4·3	1·1	2·6	Ulverston.
6·8	11·4	9·6	8·0	6·8	12·0	10·3	8·5	Warrington.
7·2	9·5	9·4	8·8	7·2	9·7	9·5	9·0	West Derby.
14·9	9·0	6·8	6·2	15·1	11·2	7·9	7·3	Wigan.
20·4	16·8	12·7	11·4	21·7	23·7	16·2	15·3	
								LEICESTER.
61·5	34·5	24·0	25·1	65·0	64·7	42·2	42·2	Ashby-de-la-Zouch.
75·8	16·1	33·0	25·2	84·9	79·6	69·0	68·7	Barrow-on-Soar.
17·1	9·5	14·2	13·6	19·2	22·3	28·4	23·5	Billesdon.
74·6	62·9	27·3	14·2	83·6	82·4	59·8	66·7	Blaby.
66·4	24·6	48·4	21·1	77·3	72·6	71·0	54·1	Hinckley.
80·8	63·8	75·2	69·1	80·8	81·3	77·9	78·7	Leicester.
68·1	15·7	23·0	21·7	79·2	74·3	65·7	65·6	Loughborough.
38·9	48·4	16·0	6·4	41·0	63·7	24·7	27·7	Lutterworth.
43·6	21·2	13·6	10·4	50·3	67·2	52·9	51·8	Market Bosworth.
31·2	86·0	53·3	7·1	31·2	86·0	64·9	44·7	Market Harborough.
61·8	10·2	7·4	7·0	72·3	60·5	30·2	29·5	Melton Mowbray.
72·0	47·5	50·6	42·7	75·8	75·9	65·9	64·6	
								LINCOLN.
20·3	25·5	7·3	4·1	30·2	38·1	21·7	26·2	Boston.
16·5	20·4	23·7	16·7	17·1	28·8	25·7	18·4	Bourne.
8·6	6·5	3·7	3·1	9·3	20·1	24·3	18·5	Caistor.
53·4	14·0	18·9	23·0	61·9	61·6	43·1	49·6	Gainsborough.
23·8	7·2	9·2	5·7	32·0	50·1	31·0	34·6	Glanford Brigg.
7·6	17·4	10·3	6·1	8·3	26·5	16·8	14·1	Grantham.

received in respect of the children born in 1897 has not been included in the Percentages "Not

APP. A, No. 3.

Analysis of Vaccination Officers' Returns 1893–1900.

—	Number of Births in 1900.	Percentages of Births: Certificates of "Successful Vaccination." (1) 1893–97.	1898.	1899.	1900.	Certificates of "Conscientious Objection." (2) 1898.	1899.	1900.
LINCOLN—*cont.*								
Grimsby	2,580	62·9	50·3	57·5	63·1	5·5	5·6	3·4
Holbeach	419	36·8	51·1	65·4	69·2	31·4	23·7	19·1
Horncastle	399	70·2	70·8	76·9	81·2	2·2	1·5	2·0
Lincoln	1,884	74·7	68·5	70·9	71·6	7·3	7·7	10·7
Louth	684	76·4	66·3	80·6	78·8	5·8	5·9	8·6
Sleaford	605	65·2	56·7	74·0	76·4	20·1	5·8	8·3
Spalding	553	30·9	36·3	63·1	60·2	37·3	20·9	25·9
Spilsby	553	84·9	84·8	85·4	88·8	1·2	0·7	0·5
Stamford	404	84·4	81·3	76·6	80·7	3·0	5·7	10·1
	13,158	63·1	54·6	65·2	67·4	16·7	11·1	12·8
MIDDLESEX (EXTRA-METROPOLITAN).								
Brentford	4,678	80·6	65·5	71·0	76·3	0·6	0·4	0·5
Edmonton	·9,532	67·2	51·3	59·3	61·4	1·7	1·7	1·7
Hendon	1,332	73·1	72·8	69·0	79·8	3·0	3·4	3·8
Staines	951	76·0	75·0	80·3	79·5	1·0	0·9	0·7
Uxbridge	1,037	85·7	82·0	80·8	82·1	1·9	2·1	1·4
Willesden	3,560	64·1†	55·3	65·6	65·1	1·3	2·0	3·4
	21,090	72·7	59·2	65·6	68·3	1·5	1·6	1·8
MONMOUTH.								
Abergavenny	775	80·9	71·8	67·6	68·3	0·5	8·8	9·5
Bedwellty	3,142	63·9	58·2	66·3	70·6	1·0	0·8	2·3
Chepstow	497	72·9	70·4	66·7	71·8	13·5	9·4	8·0
Monmouth	813	64·8	44·8	59·8	62·2	23·5	15·6	20·4
Newport	3,663	81·1	71·9	73·5	74·7	1·7	3·5	4·0
Pontypool	1,573	73·1	80·6	74·1	69·8	0·6	3·4	6·7
	10,463	73·3	66·9	69·7	71·1	3·6	4·3	5·8
NORFOLK.								
Aylsham	423	85·0	79·2	86·1	82·3	4·6	3·8	5·4
Blofield	279	75·2	79·6	84·2	83·1	2·2	6·7	7·2
Depwade	512	83·1	77·5	80·7	81·4	7·7	7·6	7·0
Docking	446	81·3	86·9	86·9	81·2	1·6	4·7	7·4
Downham	470	83·9	80·4	84·2	86·4	1·6	0·7	0·2
Erpingham	562	78·5	71·7	75·5	71·3	8·4	8·4	11·7
Faith, St.	358	54·6	61·2	75·5	73·5	22·7	11·2	10·9
Flegg, East and West	283	80·1	77·7	82·0	83·4	2·5	1·7	3·2
Forehoe	267	76·0	52·6	72·8	75·3	7·1	5·2	6·0
Freebridge Lynn	309	86·7	83·2	80·3	83·2	1·2	8·3	7·1
Guiltcross	217	85·9	77·3	77·9	84·8	6·7	5·7	4·6
Henstead	253	76·2	75·6	79·8	86·2	5·7	6·9	3·6
King's Lynn	556	5·1	5·1	12·9	14·2	2·5	12·3	9·5
Loddon and Clavering ..	313	83·3	80·4	85·5	86·6	1·3	2·0	2·2
Mitford and Launditch ..	563	81·1	74·2	74·1	80·8	4·6	4·2	5·9
Norwich	3,245	11·0	12·2	48·6	43·1	52·5	31·7	38·9
Smallburgh	424	76·6	76·0	81·0	84·9	3·2	5·9	6·2
Swaffham	271	76·2	76·6	81·9	77·8	4·3	2·3	4·8
Thetford	388	86·7	76·6	81·7	81·2	9·1	6·5	9·3
Walsingham	508	80·9	77·6	76·4	78·7	7·0	7·4	9·8
Wayland	244	84·8	74·9	79·5	77·9	7·1	5·6	5·3
Yarmouth, Great	1,378	71·3	64·3	76·6	81·8	8·9	3·8	4·6
	12,269	58·4	54·3	68·5	67·9	18·4	12·5	15·0

* In the Returns for the years 1893–97 the Number of Certificates of Conscientious Objection finally accounted for," but allowance has been made for these in the "Total Unvaccinated."

† Willesden, for year 1897 only.

IN RESPECTIVE YEARS.

Children not finally accounted for. (3)				Total Unvaccinated. (Col. 2 + Col. 3.)				—
* 1893-97.	1898.	1899.	1900.	* 1893-97.	1898.	1899.	1900.	
								LINCOLN—*cont.*
20·9	24·9	19·4	18·1	21·3	30·4	25·0	21·5	Grimsby.
45·6	5·5	2·1	2·6	52·7	36·9	25·8	21·7	Holbeach.
21·0	19·9	13·7	9·3	21·2	23·1	15·2	11·3	Horncastle.
12·1	9·2	6·9	5·0	12·4	16·5	14·6	15·7	Lincoln.
13·7	16·7	3·8	3·5	14·0	22·5	9·7	12·1	Louth.
21·4	9·7	11·5	7·3	24·7	29·8	17·3	15·6	Sleaford.
53·5	17·8	5·9	4·9	59·7	55·1	26·8	30·8	Spalding.
5·4	3·3	2·2	1·6	5·4	4·5	2·9	2·1	Spilsby.
6·0	6·7	5·7	1·7	6·0	9·7	11·4	11·8	Stamford.
22·4	15·1	10·9	9·1	24·8	31·8	22·0	21·9	
								MIDDLESEX (EXTRA-METROPOLITAN).
8·9	21·4	15·6	11·9	8·9	22·0	16·0	12·4	Brentford.
23·1	36·5	27·1	26·3	23·2	38·2	28·8	28·0	Edmonton.
17·5	12·6	15·2	9·1	17·5	15·6	18·6	12·9	Hendon.
14·8	14·4	9·9	9·4	14·8	15·4	10·8	10·1	Staines.
6·3	7·4	6·0	6·1	6·3	9·3	8·1	7·5	Uxbridge.
24·9†	33·6	19·3	23·1	24·9†	34·9	21·3	25·5	Willesden.
18·4	28·6	20·6	19·6	18·5	30·1	22·2	21·4	
								MONMOUTH
8·6	15·9	10·5	9·9	8·6	16·4	19·3	19·4	Abergavenny.
25·4	29·7	16·7	15·1	25·4	30·7	17·5	17·4	Bedwelty.
17·4	7·9	13·0	11·3	18·8	21·4	22·4	19·3	Chepstow.
22·0	23·0	15·8	6·9	25·8	46·5	31·4	27·3	Monmouth.
7·3	14·3	9·4	9·8	7·4	16·0	12·0	13·8	Newport.
17·0	9·7	10·7	12·0	17·0	10·3	14·1	18·7	Pontypool.
15·6	18·6	12·4	11·5	16·0	22·2	16·7	17·3	
								NORFOLK.
5·4	3·9	1·8	3·1	5·5	8·5	5·6	8·5	Aylesham.
13·0	8·0	1·4	1·8	13·2	10·2	8·1	9·0	Blofield.
8·8	6·5	4·2	3·9	9·1	14·2	11·8	10·9	Depwade.
10·9	5·1	1·6	3·1	11·0	6·7	6·3	10·5	Docking.
5·4	7·3	2·7	5·1	5·4	8·9	3·4	5·3	Downham.
12·3	10·1	7·2	8·2	13·0	18·5	15·6	19·9	Erpingham.
30·2	7·3	5·7	3·9	33·6	30·0	16·9	14·8	Faith, St.
6·4	5·0	4·4	2·5	6·8	7·5	6·1	5·7	Flegg, East and West.
16·3	34·3	13·1	11·2	16·6	41·4	18·3	17·2	Forehoe.
5·7	4·4	3·0	2·9	5·9	5·6	11·3	10·0	Freebridge Lynn.
6·1	7·6	5·3	4·1	6·4	14·3	11·0	8·7	Guiltcross.
15·3	10·2	3·8	4·0	15·9	15·9	10·7	7·6	Henstead.
78·8	71·5	59·9	62·9	78·8	74·0	72·2	72·4	King's Lynn.
7·5	8·5	3·0	1·6	7·7	9·8	5·0	3·8	Loddon and Clavering.
9·3	11·0	10·5	3·4	9·6	15·6	14·7	9·3	Mitford and Launditch.
63·0	17·4	3·7	3·7	72·3	69·9	36·4	42·6	Norwich.
13·4	7·9	3·1	2·1	13·6	11·1	9·0	7·3	Smallburgh.
15·7	10·8	7·2	8·1	15·7	15·1	9·5	12·9	Swaffham.
4·1	3·3	5·6	3·4	4·5	12·4	12·1	12·7	Thetford.
8·3	6·1	4·8	3·9	8·8	13·1	12·2	13·7	Walsingham.
5·3	4·3	5·6	4·5	5·7	11·4	11·2	9·8	Wayland.
15·8	10·5	5·1	2·0	16·7	19·4	8·9	6·6	Yarmouth, Great.
27·2	13·9	7·1	6·5	30·0	32·3	19·6	21·5	

received in respect of the children born in 1897 has not been included in the Percentages " Not

App. A No. 3.

Analysis of Vaccination Officers' Returns, 1893-1900.

—	Number of Births in 1900.	Percentages of Births: Certificates of "Successful Vaccination." (1) 1893-97	1898.	1899.	1900.	Certificates of "Conscientious Objection." (2) 1898.	1899.	1900.
NORTHAMPTON.								
Brackley	251	39·1	18·4	56·7	59·8	10·9	8·8	10·8
Brixworth	269	42·9	17·8	42·3	54·3	26·4	13·8	5·6
Daventry	440	51·1	42·0	55·1	57·3	19·4	11·2	12·3
Hardingstone	301	38·5	29·8	58·0	48·5	48·5	24·5	33·6
Kettering	1,474	1·6	2·4	12·6	17·3	32·5	9·4	13·4
Northampton	2,419	3·7	4·2	14·0	13·2	48·5	12·8	22·1
Oundle	216	82·8	82·4	83·7	85·2	2·3	2·8	3·7
Peterborough	1,495	84·0	71·3	75·8	77·6	0·8	2·4	2·4
Potterspury	315	58·9	43·3	62·5	57·1	38·0	22·1	27·3
Thrapston	400	10·9	19·3	39·9	40·8	44·9	42·6	46·5
Towcester	266	38·9	36·1	52·9	48·1	42·8	20·0	30·5
Wellingborough	1,646	1·1	2·0	12·2	10·0	43·0	15·3	10·9
	9,492	25·7	21·4	33·5	34·2	33·3	12·9	15·9
NORTHUMBERLAND.								
Alnwick	621	80·3	71·9	70·4	78·4	2·9	1·2	1·0
Belford	133	87·4	85·3	93·3	93·2	0·8	0·8	—
Bellingham	136	84·9	71·3	83·4	81·6	2·1	6·0	5·9
Berwick-upon-Tweed ..	482	85·7	86·3	85·6	86·3	—	—	—
Castle Ward	896	77·9	55·7	57·5	36·6	2·3	3·9	4·9
Glendale	• 167	88·5	90·9	88·2	88·0	0·5	0·5	0·6
Haltwhistle	242	41·1	45·8	58·5	53·7	30·7	29·9	33·9
Hexham	910	81·0	64·9	69·0	65·7	2·0	8·0	13·0
Morpeth	1,964	50·2	36·5	37·7	42·4	0·6	1·3	1·3
Newcastle-on-Tyne ..	7,816	76·6	66·5	74·4	78·0	1·3	1·3	1·9
Rothbury	147	90·6	87·7	91·9	84·3	—	—	—
Tynemouth	5,764	68·8	62·0	68·9	69·3	3·2	2·6	3·2
	19,278	72·3	62·8	68·7	69·5	2·2	2·4	3·2
NOTTINGHAM.								
Basford	4,859	54·4	35·5	53·1	53·7	16·7	9·4	13·0
Bingham	308	80·0	81·7	77·0	82·1	7·9	9·6	9·1
East Retford	666	84·2	80·0	79·8	79·9	4·7	4·5	6·2
Mansfield	3,064	52·8	53·6	47·6	44·8	1·8	2·4	2·9
Newark	768	83·4	59·5	57·7	66·8	8·0	2·0	6·8
Nottingham	6,751	43·5	32·3	49·8	57·7	20·1	8·9	10·9
Southwell	470	79·2	67·8	71·9	76·2	6·1	4·4	4·3
Worksop	1,309	83·4	72·8	73·3	75·6	1·4	2·1	2·5
	18,195	56·5	45·0	54·5	57·8	13·0	7·0	9·0
OXFORD.								
Banbury	702	20·4	33·1	50·7	47·3	46·3	29·1	32·6
Bicester	281	80·5	65·1	76·7	72·2	3·1	3·9	8·5
Chipping Norton	362	54·2	50·0	66·2	62·2	12·8	11·8	15·2
Headington	916	88·8	87·8	84·1	86·0	1·8	3·5	2·8
Henley	582	78·9	69·7	79·1	80·8	6·9	5·3	8·2
Oxford	545	83·5	78·4	82·1	84·0	4·0	4·3	4·0
Thame	270	83·4	81·0	77·5	77·4	6·8	9·9	14·1
Witney	459	86·8	81·5	80·3	78·7	3·7	6·8	8·9
Woodstock	286	83·2	83·8	81·6	75·9	5·0	9·5	15·0
	4,403	71·7	69·7	74·6	74·1	11·3	10·1	11·9

• In the Returns for the years 1893-97 the Number of Certificates of Conscientious Objection finally accounted for," but allowance has been made for these in the "Total Unvaccinated."

IN RESPECTIVE YEARS.

Children not finally accounted for. (3)				Total Unvaccinated. (Col. 2 + Col. 3.)				
* 1893-97.	1898.	1899.	1900.	* 1893-97.	1898.	1899.	1900.	
								NORTHAMPTON.
47·7	63·5	23·9	22·7	49·3	74·4	32·7	33·5	Brackley
44·2	48·6	37·9	32·7	49·2	75·0	51·7	38·3	Brixworth.
36·3	29·7	25·0	21·6	39·4	49·1	36·2	33·9	Daventry.
42·7	11·3	7·0	10·3	51·1	59·8	31·5	43·9	Hardingstone.
84·2	48·2	62·1	57·7	84·2	80·7	71·5	71·1	Kettering.
74·2	32·9	60·7	54·1	83·3	81·4	73·5	76·2	Northampton.
9·0	8·1	5·6	5·1	9·2	10·4	8·4	8·8	Oundle.
7·6	16·7	11·1	9·1	7·6	17·5	13·5	11·5	Peterborough.
29·2	10·0	5·0	3·8	33·0	48·0	27·1	31·1	Potterspury.
72·0	26·7	9·2	7·0	79·7	71·6	51·8	53·5	Thrapston.
43·9	10·4	17·3	15·8	50·7	53·2	37·3	46·3	Towcester.
82·2	43·1	61·0	67·9	86·4	86·1	76·3	78·8	Wellingborough.
58·4	33·0	41·9	39·8	62·8	66·3	54·8	55·7	
								NORTHUMBERLAND.
10·2	14·0	17·8	10·0	10·2	16·9	19·0	11·0	Alnwick.
3·6	1·6	0·8	3·0	3·6	2·4	1·6	3·0	Belford.
9·6	14·0	6·0	4·4	9·6	16·1	12·0	10·3	Bellingham.
3·3	4·1	3·3	2·9	3·3	4·1	3·3	2·9	Berwick-upon-Tweed.
11·5	31·4	30·2	49·3	11·5	33·7	34·1	54·2	Castle Ward.
4·9	1·5	3·2	2·4	4·9	2·0	3·7	3·0	Glendale.
45·3	16·9	2·6	3·7	50·6	47·6	32·5	37·6	Haltwhistle.
10·6	21·1	11·0	9·0	10·7	23·1	19·0	22·0	Hexham.
31·7	44·0	41·4	40·5	31·7	44·6	42·7	41·8	Morpeth.
11·5	18·4	10·0	8·0	11·6	19·7	11·3	9·9	Newcastle-on-Tyne.
1·7	4·1	0·7	2·7	1·7	4·1	0·7	2·7	Rothbury.
17·4	20·0	13·4	14·6	17·8	23·2	16·0	17·8	Tynemouth.
15·1	21·0	14·7	15·0	15·3	23·2	17·1	18·2	
								NOTTINGHAM.
29·2	33·8	23·9	20·2	32·5	50·5	33·3	33·2	Basford.
10·3	4·1	4·8	2·3	11·9	12·0	14·4	11·4	Bingham.
6·7	6·8	6·0	4·1	7·0	11·5	10·5	10·3	East Retford.
34·5	28·0	32·5	38·3	34·7	29·8	34·9	41·2	Mansfield.
7·4	22·9	29·8	15·5	7·9	30·9	31·8	22·3	Newark.
37·4	30·4	24·4	16·1	41·3	50·5	33·3	27·0	Nottingham.
12·5	16·0	14·3	7·7	12·9	22·1	18·7	12·0	Southwell.
6·7	11·6	9·8	9·1	6·8	13·0	11·9	11·6	Worksop.
28·2	27·8	23·4	19·5	30·7	40·8	30·4	28·5	
								OXFORD.
61·2	11·9	12·2	12·8	69·7	58·2	41·3	45·4	Banbury
11·1	22·0	10·0	11·7	11·2	25·1	13·9	20·2	Bicester.
34·0	29·5	13·8	12·7	36·1	42·3	25·6	27·9	Chipping Norton.
2·8	2·4	3·1	3·1	2·9	4·2	6·6	5·9	Headington.
12·1	18·5	6·2	5·0	12·4	25·4	11·5	13·2	Henley.
5·6	7·3	3·9	3·7	5·6	11·3	8·2	7·7	Oxford.
8·4	4·0	2·6	2·2	9·0	10·8	12·5	16·3	Thame.
5·2	6·7	4·1	5·9	5·3	10·4	10·9	14·8	Witney.
9·1	6·5	4·7	3·1	9·2	11·5	14·2	18·1	Woodstock.
17·8	11·1	6·7	6·5	19·4	22·4	16·8	18·4	

received in respect of the children born in 1897 has not been included in the Percentages "Not

App. A, No. 3.

Analysis of Vaccination Officers' Returns, 1893-1900.

—	Number of Births in 1900.	Percentages of Births: Certificates of "Successful Vaccination." (1) 1893-97.	1898.	1899.	1900.	Certificates of "Conscientious Objection." (2) 1898.	1899.	1900.
RUTLAND.								
Oakham	250	85·9	83·2	87·7	89·2	3·7	4·1	3·2
Uppingham	206	85·1	85·2	84·2	81·1	2·8	7·2	10·2
	456	85·5	84·1	86·1	85·5	3·3	5·5	6·4
SALOP.								
Atcham	1,171	78·6	79·9	83·2	85·9	0·5	1·0	1·2
Bridgnorth	362	84·0	80·9	82·5	85·9	1·6	3·8	3·6
Church Stretton	107	89·4	86·6	94·5	90·7	1·6	—	0·9
Cleobury Mortimer	219	88·0	87·0	87·7	85·9	0·9	2·3	3·2
Clun	212	58·1	73·6	81·0	80·7	0·9	2·2	6·6
Drayton	334	89·5	85·9	85·8	81·7	0·8	1·2	2·4
Ellesmere	370	89·0	89·5	86·5	84·9	—	0·3	0·5
Ludlow	466	84·4	80·1	82·3	84·5	2·9	2·6	4·9
Madeley	694	86·9	82·2	84·1	89·8	0·5	1·2	0·7
Newport	342	85·6	79·4	82·7	84·8	0·5	—	0·3
Oswestry	732	87·4	86·2	87·2	87·7	0·5	0·8	1·2
Shifnal	299	77·1	83·2	82·0	90·0	—	0·3	0·7
Wellington	792	48·4	54·4	66·7	81·0	5·7	0·9	1·9
Wem	267	91·9	81·7	84·2	88·8	3·4	3·0	2·6
Whitchurch	296	87·5	76·7	75·9	84·1	—	1·9	2·4
	6,663	80·1	79·3	81·9	85·6	1·4	1·3	1·9
SOMERSET.								
Axbridge	953	36·4	36·8	51·1	48·7	27·8	16·3	20·2
Bath	1,668	68·2	55·5	61·2	67·2	3·5	5·3	5·6
Bridgwater	904	62·9	58·6	56·1	54·3	5·2	10·2	9·4
Chard	614	85·9	84·2	83·4	84·7	1·2	1·6	1·8
Clutton	782	75·9	66·2	71·3	71·9	4·1	9·8	13·8
Dulverton	93	90·8	87·3	89·3	89·3	1·8	5·4	3·2
Frome	479	78·7	60·2	75·2 *	71·8	8·3	11·5	16·9
Keynsham	1,040	51·8	37·6	48·8	48·7	2·2	4·1	3·7
Langport	347	80·7	80·9	78·5	77·8	2·3	8·5	11·2
Long Ashton	546	56·0	64·0	64·4	69·2	1·3	5·4	5·7
Shepton Mallet	372	73·9	65·8	62·4	76·6	18·5	15·4	11·0
Taunton	925	84·8	80·3	75·3	81·8	2·5	8·0	5·9
Wellington	445	78·6	75·4	79·3	81·1	10·1	8·9	8·5
Wells	514	76·6	63·0	65·1	61·5	1·8	6·8	7·2
Williton	351	88·7	84·8	81·5	78·6	5·9	4·2	5·1
Wincanton	340	81·9	73·3	75·2	80·3	7·6	5·3	4·4
Yeovil	670	77·2	74·2	75·8	74·3	8·1	11·0	13·3
	11,043	68·2	62·5	66·3	68·0	6·7	8·1	8·9
SOUTHAMPTON.								
Alresford	157	93·6	90·8	89·7	90·4	2·3	—	—
Alton	400	86·6	86·2	82·4	87·0	0·8	1·1	0·3
Alverstoke	823	88·7	82·5	83·1	86·3	0·6	0·1	0·2
Andover	351	79·1	72·7	69·1	71·2	10·3	12·6	13·7
Basingstoke	561	55·0	67·0	71·8	78·6	5·5	13·5	11·2
Catherington	56	79·2	85·5	90·2	87·5	4·3	2·4	3·6
Christchurch	1,234	60·3	39·7	61·9	70·4	2·2	1·2	2·0
Droxford	280	89·4	91·6	88·1	89·6	0·7	0·7	0·4
Fareham	486	90·0	87·2	84·8	86·0	1·1	0·4	0·6
Fordingbridge	145	88·2	80·9	81·8	80·0	9·9	8·5	7·6

* In the Returns for the years 1893-97 the Number of Certificates of Conscientious Objection finally accounted for" but allowance has been made for these in the "Total Unvaccinated."

IN RESPECTIVE YEARS.

Children not finally accounted for. (3)				Total Unvaccinated. (Col. 2 + Col. 3.)				—
* 1893-97.	1898.	1899.	1900.	* 1893-97.	1898.	1899.	1900.	
								RUTLAND.
5·1	3·3	1·1	1·2	5·2	7·0	5·2	4·4	Oakham.
5·5	4·2	1·4	2·4	5·8	7·0	8·6	12·6	Uppingham.
5·3	3·7	1·2	1·8	5·5	7·0	6·7	8·2	
								SALOP.
11·9	8·9	5·7	3·2	11·9	9·4	6·7	4·4	Atcham.
7·0	6·7	4·8	1·7	7·1	8·3	8·6	5·3	Bridgnorth.
2·2	1·6	0·9	1·9	2·4	3·2	0·9	2·8	Church Stretton.
4·8	4·5	4·1	1·4	4·8	5·4	6·4	4·6	Cleobury Mortimer.
34·1	17·9	10·2	4·6	34·2	18·8	12·4	11·2	Clun.
1·6	2·8	3·0	2·4	1·7	3·6	4·2	4·8	Drayton.
2·9	1·6	2·7	2·4	2·9	1·6	3·0	2·9	Ellesmere.
7·3	7·0	4·1	2·1	7·5	9·9	6·7	7·0	Ludlow.
5·1	7·7	5·0	1·6	5·2	8·2	6·2	2·3	Madeley.
5·3	9·1	5·9	5·3	5·3	9·6	5·9	5·6	Newport.
3·9	5·3	2·3	2·9	3·9	5·8	3·1	4·1	Oswestry.
13·0	8·5	7·5	1·3	15·7	8·5	7·8	2·0	Shifnal.
38·8	28·2	22·9	7·7	39·7	33·9	23·8	9·6	Wellington.
1·6	4·1	4·9	3·7	1·6	7·5	7·9	6·3	Wem.
4·9	13·4	14·8	7·1	5·1	13·4	16·7	9·5	Whitchurch.
10·7	9·4	7·0	3·5	11·0	10·8	8·3	5·4	
								SOMERSET.
49·1	23·1	22·2	21·1	54·4	50·9	38·5	41·3	Axbridge.
20·7	28·8	21·5	17·6	20·8	32·3	26·8	23·2	Bath.
27·2	26·4	24·8	27·5	27·9	31·6	35·0	36·9	Bridgwater.
5·5	4·8	4·9	4·6	5·5	6·0	6·5	6·4	Chard.
16·1	21·4	8·9	6·4	16·5	25·5	18·7	20·2	Clutton.
2·2	0·9	—	1·1	2·2	2·7	5·4	4·3	Dulverton.
13·4	22·9	5·4	4·0	14·4	31·2	16·9	20·9	Frome.
38·4	51·6	34·4	38·7	38·6	53·8	38·5	42·4	Keynsham.
12·1	9·2	4·7	2·6	12·1	11·5	13·2	13·8	Langport.
32·8	26·4	20·0	16·8	32·8	27·7	25·4	22·5	Long Ashton.
16·4	8·7	10·8	6·7	19·5	27·2	26·2	17·7	Shepton Mallet.
5·9	8·0	3·7	2·5	5·9	10·5	11·7	8·4	Taunton.
13·3	6·6	3·3	3·8	14·0	16·7	12·2	12·3	Wellington.
14·0	25·0	18·6	22·2	14·3	26·8	25·4	29·4	Wells.
4·5	3·5	3·6	7·1	4·6	9·4	7·8	12·2	Williton.
9·4	12·5	10·2	7·9	9·7	20·1	15·5	12·3	Wincanton.
13·3	9·2	5·3	5·8	14·1	17·3	16·3	19·1	Yeovil.
21·9	21·3	15·1	14·6	23·7	28·0	23·2	23·5	
								SOUTHAMPTON.
2·4	1·1	3·8	2·5	2·4	3·4	3·8	2·5	Alresford.
6·1	5·6	5·7	4·7	6·1	6·4	6·8	5·0	Alton.
2·3	4·6	3·7	2·2	2·3	5·2	3·8	2·4	Alverstoke.
12·7	10·6	7·1	7·4	13·6	20·9	19·7	21·1	Andover.
38·3	17·9	6·0	4·3	38·8	23·4	19·5	15·5	Basingstoke.
10·5	5·8	2·4	5·4	10·5	10·1	4·8	9·0	Catherington.
30·1	48·9	24·4	18·3	30·2	51·1	25·6	20·3	Christchurch.
3·2	2·2	3·7	3·6	3·2	2·9	4·4	4·0	Droxford.
3·4	6·3	5·1	5·1	3·4	7·4	5·5	5·7	Fareham.
5·1	5·3	2·8	7·6	5·2	15·2	11·3	15·2	Fordingbridge.

received in respect of the children born in 1897 has not been included in the Percentages "Not

APP. A, No. 3.

Analysis of Vaccination Officers' Returns, 1893–1900.

—	Number of Births in 1900.	Percentages of Births						
		Certificates of "Successful Vaccination." (1)				Certificates of "Conscientious Objection." (2)		
		1893–97.	1898.	1899.	1900.	1898.	1899.	1900.
SOUTHAMPTON—*cont.*								
Hartley Wintney	667	79·1	78·2	82·9	82·7	2·1	1·0	2·8
Havant	258	88·1	84·2	85·1	88·8	0·4	1·8	1·2
Hursley	99	90·1	88·4	83·8	90·9	—	1·0	—
Kingsclere	215	90·5	86·3	88·7	91·6	1·8	3·6	3·7
Lymington	294	81·9	67·0	80·9	81·6	1·3	1·3	2·0
New Forest	355	85·4	79·6	84·6	91·0	0·3	0·6	0·6
Petersfield	306	84·9	75·1	80·3	83·3	5·2	3·7	1·3
Portsmouth	5,036	86·9	85·3	83·7	87·1	1·2	0·5	0·7
Ringwood..	187	89·0	81·4	86·0	87·2	1·2	0·7	1·1
Romsey	262	88·5	76·9	83·9	85·5	3·3	6·7	4·6
Southampton	1.751	81·9	78·3	77·2	79·8	1·7	2·2	1·6
South Stoneham	2,240	77·8	67·0	72·6	78·7	1·6	2·4	2·1
Stockbridge	155	86·8	80·4	82·9	91·0	4·2	5·9	3·9
Whitchurch	151	84·4	74·2	78·1	81·4	3·2	1·8	3·3
Wight, Isle of	1,772	78·5	61·9	77·0	80·1	8·8	6·9	6·0
Winchester, New	708	83·7	79·7	80·1	84·0	5·0	4·3	4·2
	18,949	81·4	75·2	78·9	82·9	2·7	2·6	2·5
STAFFORD.								
Burton-upon-Trent	2,727	46·4	37·2	55·9	51·5	0·7	2·6	3·8
Cannock	1,640	74·3	79·8	81·6	83·9	2·4	1·6	2·0
Cheadle	762	80·1	82·7	83·2	84·8	0·9	1·2	0·9
Leek	1,312	79·0	73·6	80·9	80·0	12·4	4·1	5·3
Lichfield	1,282	86·6	87·0	82·3	84·4	0·7	1·2	1·2
Newcastle-under-Lyme ..	1,282	88·9	84·2	85·5	85·3	0·5	0·2	0·5
Seisdon	467	76·0	76·2	80·5	83·1	3·1	2·9	3·4
Stafford	798	82·9	79·0	81·3	79·3	5·4	4·3	5·9
Stoke-upon-Trent	5,821	74·8	67·7	64·7	69·7	0·4	0·4	0·5
Stone	506	82·9	59·9	82·3	85·0	0·8	0·9	1·6
Tamworth	747	67·8	55·6	68·7	73·0	3·0	2·0	1·1
Uttoxeter..	399	79·8	73·2	86·5	83·0	1·7	1·3	2·3
Walsall	4,094	48·9	55·2	59·4	65·2	1·4	1·2	1·6
West Bromwich	6,502	41·9	39·8	51·1	43·6	8·8	1·7	1·7
Wolstanton and Burslem ..	3,787	78·5	72·3	75·4	77·1	0·3	0·3	0·1
Wolverhampton	5,255	46·3	37·9	57·8	54·6	4·2	4·3	4·0
	36,379	62·6	56·6	65·6	65·7	3·1	1·8	2·0
SUFFOLK.								
Blything	650	88·9	89·8	89·9	89·5	2·0	0·9	2·3
Bosmere and Claydon ..	364	84·9	71·0	77·3	79·4	12·5	5·8	3·8
Bury St. Edmunds	398	81·8	72·5	67·9	72·8	5·1	5·7	7·3
Cosford	405	89·3	84·1	91·0	89·6	3·5	1·0	1·2
Hartismere	301	84·1	75·9	87·6	86·4	3·7	1·9	0·3
Hoxne	282	87·5	90·0	85·7	90·1	1·3	2·4	0·7
Ipswich	1,800	37·7	21·7	43·6	43·6	11·1	14·5	19·4
Mildenhall	234	88·8	86·0	86·6	91·4	0·9	0·5	—
Mutford and Lothingland .	1,272	81·1	66·2	75·9	75·4	1·8	2·1	3·0
Plomesgate	479	84·6	84·6	83·1	84·8	4·6	3·1	2·9
Risbridge	415	86·2	79·7	85·8	85·3	5·1	2·7	4·1
Samford	336	87·0	85·3	88·7	89·0	3·1	—	1·5
Stow	487	88·6	77·4	84·7	85·6	8·2	3·4	4·3
Sudbury	600	83·0	82·5	84·4	85·3	4·2	3·1	4·2
Thingoe	371	89·5	84·8	86·4	89·2	3·1	1·7	1·6
Wangford..	358	88·9	84·2	86·4	86·3	1·8	2·9	2·5
Woodbridge	588	82·8	78·8	77·4	78·2	2·9	1·9	2·4
	9,340	77·0	68·0	75·5	75·8	5·3	4·7	6·1

* In the Returns for the years 1893–97 the Number of Certificates of Conscientious Objection finally accounted for," but allowance has been made for these in the "Total Unvaccinated."

IN RESPECTIVE YEARS.

Children not finally accounted for. (3)				Total Unvaccinated. (Col. 2 + Col. 3.)				
* 1893-97.	1898.	1899.	1900.	* 1893-97.	1898.	1899.	1900.	
								SOUTHAMPTON—*cont.*
12·3	10·8	6·5	3·9	12·5	12·9	7·5	6·7	Hartley Wintney.
5·4	9·2	5·1	3·9	5·4	9·6	6·9	5·1	Havant.
4·6	7·4	11·1	3·0	4·6	7·4	12·1	3·0	Hursley.
2·6	2·3	0·5	1·9	2·6	4·1	4·1	5·6	Kingsclere.
10·2	18·7	11·8	9·2	10·3	20·0	13·1	11·2	Lymington.
8·8	11·3	7·6	4·8	8·8	11·6	8·2	6·4	New Forest.
8·6	11·7	6·9	8·8	8·7	16·9	10·6	10·1	Petersfield.
2·7	2·3	1·6	1·5	2·7	3·5	2·1	2·2	Portsmouth.
3·3	6·0	5·3	4·3	3·3	7·2	6·0	6·4	Ringwood.
4·8	12·3	2·2	2·7	5·0	15·6	8·9	7·3	Romsey.
6·4	7·9	6·7	5·9	6·4	9·6	8·9	7·5	Southampton.
13·3	20·3	14·6	10·1	13·3	21·9	17·0	12·2	South Stoneham.
6·0	7·7	3·7	2·6	6·3	11·9	9·6	6·5	Stockbridge.
7·6	10·2	10·1	8·6	7·6	13·4	11·9	11·9	Whitchurch.
13·3	21·3	7·5	7·2	13·9	30·1	14·4	13·2	Wight, Isle of.
6·5	6·7	6·5	3·2	6·6	11·7	10·8	7·4	Winchester, New.
9·5	12·2	7·3	5·6	9·6	14·9	9·9	8·1	
								STAFFORD.
41·6	49·3	29·8	34·6	41·7	50·0	32·4	38·4	Burton-upon-Trent.
14·5	7·0	5·5	3·8	14·7	9·4	7·1	5·8	Cannock.
10·1	5·7	6·1	5·4	10·1	6·6	7·3	6·3	Cheadle.
8·5	4·7	3·3	2·4	10·1	17·1	7·4	7·7	Leek.
3·6	3·7	4·5	4·5	3·6	4·4	5·7	5·7	Lichfield.
1·3	3·8	1·9	2·6	1·3	4·3	2·1	3·1	Newcastle-under-Lyne.
14·6	9·8	5·8	5·1	14·8	12·9	8·7	8·5	Seisdon.
7·8	5·7	5·7	5·5	7·9	11·1	10·0	11·4	Stafford.
10·0	25·2	16·7	14·4	10·0	25·6	17·1	14·9	Stoke-upon-Trent.
6·1	30·0	6·3	3·8	6·1	30·8	7·2	5·4	Stone.
21·4	31·0	19·7	15·4	22·1	34·0	21·7	16·5	Tamworth.
10·8	13·7	5·0	8·0	10·8	15·4	6·3	10·3	Uttoxeter.
34·3	26·3	21·4	16·8	34·4	27·7	22·6	18·4	Walsall.
44·7	36·5	32·3	40·9	44·7	45·3	34·0	42·6	West Bromwich.
7·7	12·6	10·3	7·5	7·7	12·9	10·6	7·6	Wolstanton and Burslem.
37·4	41·6	23·3	28·5	37·8	45·8	27·6	32·5	Wolverhampton.
23·9	26·0	18·2	19·1	24·1	29·1	20·0	21·1	
								SUFFOLK.
3·4	0·7	0·8	1·4	3·4	2·7	1·7	3·7	Blything.
7·6	9·3	6·1	7·4	7·8	21·8	11·9	11·2	Bosmere and Claydon.
8·0	11·1	15·6	10·1	8·0	16·2	21·3	17·4	Bury St. Edmunds.
3·0	3·7	2·3	2·2	3·2	7·2	3·3	3·4	Cosford.
7·5	8·4	4·1	3·0	7·8	12·1	6·0	3·3	Hartismere.
3·8	1·7	3·5	3·9	3·9	3·0	5·9	4·6	Hoxne.
47·2	52·1	25·7	24·1	48·9	63·2	40·2	43·5	Ipswich.
2·9	2·3	4·3	2·6	3·0	3·2	4·8	2·6	Mildenhall.
9·5	20·5	13·6	13·1	9·6	22·3	15·7	16·1	Mutford and Lothingland.
6·8	4·2	5·5	4·8	7·0	8·8	8·6	7·7	Plomesgate.
3·9	4·3	1·6	1·4	4·0	9·4	4·3	5·5	Risbridge.
3·4	2·8	1·9	0·6	3·6	5·9	1·9	2·1	Samford.
3·4	5·3	3·0	1·2	3·8	13·5	6·4	5·5	Stow.
8·4	4·2	3·9	2·8	8·5	8·4	7·0	7·0	Sudbury.
3·3	5·5	2·8	1·9	3·5	8·6	4·6	3·5	Thingoe.
2·1	3·1	2·1	2·2	2·1	4·9	5·0	4·7	Wangford.
9·2	10·9	11·2	11·6	9·2	13·8	13·1	14·0	Woodbridge.
13·3	16·4	9·7	9·1	13·7	21·7	14·4	15·2	

received in respect of the children born in 1897 has not been included in the Percentages "Not

—	Number of Births in 1900.	Percentages of Births: Certificates of "Successful Vaccination." (1) 1893-97.	1898.	1899.	1900.	Certificates of "Conscientious Objection." (2) 1898.	1899.	1900.
SURREY (EXTRA-METROPOLITAN).								
Chertsey	975	68·5	73·3	76·3	80·0	0·6	1·8	1·3
Croydon	4,717	57·1	43·6	47·4	60·2	2·0	1·6	1·5
Dorking	377	76·7	57·7	70·3	75·6	16·5	11·2	14·9
Epsom	1,334	73·1	59·7	71·8	71·3	3·6	3·0	2·4
Farnham	1,435	79·7	78·2	79·2	83·4	1·0	1·8	1·0
Godstone	592	77·6	59·5	70·9	78·5	1·5	1·5	1·5
Guildford	1,476	71·5	67·7	70·4	77·0	8·3	7·2	7·4
Hambledon	480	89·5	87·7	80·8	86·9	1·2	4·1	2·1
Kingston	3,448	77·9	66·8	65·5	76·6	1·1	2·7	2·3
Reigate	941	70·7	61·5	72·1	74·2	5·8	8·5	13·2
Richmond..	1,060	88·6	81·9	84·1	87·8	1·1	1·1	0·8
	16,835	71·7	62·3	65·8	73·3	2·8	3·1	3·1
SUSSEX.								
Battle	568	64·3	64·8	79·6	72·2	1·8	4·0	11·1
Brighton	2,482	78·5	68·4	62·5	72·2	1·1	2·0	2·8
Chichester	262	87·4	77·5	79·1	84·0	3·1	2·1	1·9
Cuckfield	537	82·6	80·3	82·5	84·7	4·5	4·4	2·2
Eastbourne	1,087	19·2	14·0	26·1	29·7	11·1	10·3	24·2
East Grinstead	425	46·7	35·3	59·4	60·7	2·6	6·7	11·1
East Preston	840	83·8	76·2	74·0	78·8	2·4	4·6	3·9
Hailsham	405	76·8	61·0	59·0	59·3	17·3	22·9	25·7
Hastings	1,280	69·6	72·1	71·4	71·3	6·2	9·2	11·5
Horsham	675	79·5	80·4	79·2	77·9	5·4	3·1	4·3
Lewes	493	34·4	35·7	35·2	46·5	33·3	30·5	30·4
Midhurst	308	88·2	86·5	90·5	87·0	2·4	0·9	1·3
Newhaven	283	80·0	65·0	52·1	61·8	7·2	15·9	27·2
Petworth	190	90·2	87·5	86·1	88·9	2·3	3·1	1·5
Rye	246	79·1	72·3	74·5	80·9	9·2	12·2	10·2
Steyning	1,694	85·3	74·2	73·2	78·4	1·7	2·7	2·8
Thakeham	159	89·7	83·1	87·0	86·8	0·5	2·2	1·3
Ticehurst	340	75·9	76·5	74·0	78·2	6·7	12·7	9·7
Uckfield	564	43·8	38·5	60·6	56·7	29·1	21·1	25·5
Westbourne	151	85·3	85·6	81·1	91·4	1·2	1·1	—
Westhampnett	431	84·2	84·6	85·3	88·2	1·1	0·7	0·9
	13,429	70·8	64·9	66·4	70·1	6·3	7·0	9·4
WARWICK.								
Alcester	515	82·5	79·5	85·3	83·1	7·7	6·0	6·4
Aston	10,464	72·0	67·1	69·1	72·0	0·4	0·4	0·5
Atherstone	589	55·2	42·0	51·0	47·9	6·1	2·0	4·9
Birmingham	8,147	77·9	70·6	65·6	67·2	0·4	0·3	0·4
Coventry	2,207	11·4	18·5	51·0	55·1	9·7	5·8	8·1
Foleshill	583	44·2	69·4	73·3	76·3	9·8	7·7	10·0
Meriden	343	77·6	66·9	61·5	74·5	1·6	2·5	4·9
Nuneaton	939	10·1	18·1	32·3	53·0	6·7	7·8	16·3
Rugby	847	38·8	10·3	11·0	29·8	1·8	1·6	3·5
Solihull	1.289	75·9	63·9	74·8	77·3	1·3	1·2	1·2
Southam	263	78·0	63·6	73·9	71·9	·3·9	11·2	14·8
Stratford-on-Avon	449	80·7	60·0	72·9	79·7	7·8	5·7	4·9
Warwick	1,137	82·5	78·1	80·7	81·1	1·6	4·5	4·8
	27,672	67·5	61·3	64·6	67·8	2·1	1·8	2·5

In the Returns for the years 1893-97 the Number of Certificates of Conscientious Objection finally accounted for," but allowance has been made for these in the "Total Unvaccinated."

App. A, No. 3.

Analysis of Vaccination Officers' Returns, 1893–1900.

IN RESPECTIVE YEARS.

Children not finally accounted for. (3)				Total Unvaccinated. (Col. 2 + Col. 3.)				—
* 1893–97.	1898.	1899.	1900.	* 1893–97.	1898.	1899.	1900.	
								SURREY (EXTRA-METROPOLITAN).
24·3	18·3	12·4	10·7	24·4	18·9	14·2	12·0	Chertsey.
33·5	43·2	39·4	28·1	33·6	45·2	41·0	29·6	Croydon.
14·7	14·3	9·1	3·4	17·7	30·8	20·3	18·3	Dorking.
17·5	27·3	15·6	18·3	17·9	30·9	18·6	20·7	Epsom.
11·6	9·7	8·8	5·1	11·6	10·7	10·6	6·1	Farnham.
15·9	27·1	17·8	12·2	16·0	28·6	19·3	13·7	Godstone
18·6	13·8	12·3	6·9	19·7	22·1	19·5	14·3	Guildford.
4·1	5·3	4·7	2·7	4·2	6·5	8·8	4·8	Hambledon.
13·6	21·6	20·9	11·7	13·6	22·7	23·6	14·0	Kingston.
21·8	23·6	9·5	5·3	22·1	29·4	18·0	18·5	Reigate.
3·3	5·3	3·9	3·1	3·3	6·4	5·0	3·9	Richmond.
19·6	24·5	20·5	14·5	19·9	27·3	23·6	17·6	
								SUSSEX.
27·0	25·1	10·3	9·5	27·0	26·9	14·3	20·6	Battle.
10·4	16·4	21·3	12·7	10·4	17·5	23·3	15·5	Brighton.
4·7	10·5	5·5	6·5	4·7	13·6	7·6	8·4	Chichester.
10·0	8·2	4·9	5·0	10·4	12·7	9·3	7·2	Cuckfield.
69·1	63·1	52·8	37·4	71·1	74·2	63·1	61·6	Eastbourne.
46·4	54·9	27·5	21·6	46·9	57·5	34·2	32·7	East Grinstead.
8·5	11·7	9·4	8·1	8·5	14·1	14·0	12·0	East Preston.
15·6	14·8	11·1	8·4	16·8	32·1	34·0	34·1	Hailsham.
20·2	10·5	8·8	8·5	20·6	16·7	18·0	20·0	Hastings.
12·1	7·8	7·8	8·4	12·5	13·2	10·9	12·7	Horsham.
48·4	23·9	27·0	14·0	53·1	57·2	57·5	44·4	Lewes.
4·4	4·0	1·8	5·5	4·5	6·4	2·7	6·8	Midhurst.
11·4	15·5	19·1	4·9	12·3	22·7	35·0	32·1	Newhaven.
2·9	1·4	1·5	2·0	2·9	3·7	4·6	3·5	Petworth.
9·5	5·9	3·3	3·3	11·5	15·1	15·5	13·5	Rye.
6·4	14·7	12·6	10·9	6·4	16·4	15·3	13·7	Steyning.
3·0	12·0	2·7	4·4	3·0	12·5	4·9	5·7	Thakeham.
15·7	11·5	7·1	5·3	16·8	18·2	19·8	15·0	Ticehurst.
44·5	23·0	11·5	10·1	48·9	52·1	32·6	35·6	Uckfield.
6·9	7·2	8·3	2·7	6·9	8·4	9·4	2·7	Westbourne.
8·2	5·6	4·5	3·0	8·3	6·7	5·2	3·9	Westhampnett.
19·5	18·8	16·1	11·7	20·2	25·1	23·1	21·1	
								WARWICK.
7·8	4·5	2·2	1·2	8·3	12·2	8·2	7·6	Alcester.
13·9	17·5	14·8	13·2	13·9	17·9	15·2	13·7	Aston.
30·3	38·7	36·2	34·0	31·2	44·8	38·2	38·9	Atherstone.
7·8	14·6	16·7	15·4	7·8	15·0	17·0	15·8	Birmingham.
69·5	55·5	30·5	26·0	73·5	65·2	36·3	34·1	Coventry.
43·3	7·0	7·8	2·2	45·0	16·8	15·5	12·2	Foleshill.
14·0	21·5	24·7	11·1	14·2	23·1	27·2	16·0	Meriden.
74·2	58·2	44·9	17·4	75·2	64·9	52·7	33·7	Nuneaton.
51·1	78·0	77·8	55·6	51·8	79·8	79·4	59·1	Rugby.
15·3	23·6	12·7	12·6	15·4	24·9	13·9	13·8	Solihull.
12·8	25·4	6·9	6·1	13·5	29·3	18·1	20·9	Southam
10·1	19·3	11·9	5·3	11·1	27·1	17·6	10·2	Stratford-on-Avon
8·7	10·2	5·1	5·2	8·7	11·8	9·6	10·0	Warwick.
19·3	22·5	18·8	15·7	19·8	24·6	20·6	18·2	

received in respect of the children born in 1897 has not been included in the Percentages "Not

App. A, No. 3.

Analysis of Vaccination Officers' Returns, 1898-1900.

—	Number of Births in 1900.	Percentages of Births: Certificates of "Successful Vaccination." (1) 1893-97.	1898.	1899.	1900.	Certificates of "Conscientious Objection." (2) 1898.	1899.	1900.
WESTMORLAND.								
East Ward	318	82·7	72·5	70·3	76·7	7·6	11·4	11·0
Kendal	943	89·7	89·5	88·3	88·8	1·4	1·3	1·5
West Ward	192	86·7	88·0	80·3	86·5	1·0	3·3	2·1
	1,453	87·9	85·7	83·6	85·8	2·7	3·6	3·6
WILTS.								
Amesbury..	162	84·6	82·5	79·4	75·3	4·9	8·0	12·3
Bradford-on-Avon	221	70·0	39·3	42·7	47·0	6·6	5·1	7·7
Calne	204	54·0	44·6	53·5	54·9	14·7	6·4	11·8
Chippenham	572	62·5	22·5	57·9	45·8	1·1	9·1	12·9
Cricklade and Wootton Bassett.	286	40·1	38·9	51·6	57·0	30·7	22·4	25·9
Devizes	490	64·4	52·2	53·8	54·5	19·4	19·7	30·6
Malmesbury	303	67·7	45·6	67·1	67·0	4·1	5·2	9·6
Marlborough	185	90·7	84·6	84·1	88·1	3·1	3·0	1·6
Mere	118	87·1	89·3	86·1	82·2	2·3	5·1	5·1
Pewsey	295	89·1	81·9	80·1	83·4	3·2	9·1	8·8
Salisbury	647	85·6	65·5	64·2	65·8	12·0	20·0	19·0
Swindon and Highworth ..	1,757	27·6	16·4	46·0	45·5	38·5	27·6	37·6
Tisbury	177	83·6	72·3	76·3	82·5	—	1·6	0·6
Trowbridge and Melksham..	421	31·9	15·3	18·7	27·3	37·1	3·8	12·8
Warminster	255	74·9	76·0	82·4	83·5	10·0	6·0	6·7
Westbury and Whorwellsdown.	238	68·6	31·3	59·2	64·3	6·6	2·9	5·5
Wilton	222	86·4	68·9	74·1	75·2	14·2	15·1	16·7
	6,553	59·2	43·0	57·3	57·4	18·7	14·9	20·3
WORCESTER.								
Bromsgrove	924	82·7	80·7	80·7	83·8	2·4	2·0	2·8
Droitwich..	470	84·5	79·8	87·2	87·7	0·9	0·6	0·9
Dudley	5,565	78·6	73·6	75·6	78·4	1·0	1·0	1·2
Evesham	500	74·0	61·0	70·3	65·0	24·6	19·3	26·8
Kidderminster	998	86·8	83·0	83·0	85·1	3·6	2·4	2·6
King's Norton	5,287	65·1	57·6	64·1	69·0	2·1	1·0	1·2
Martley	342	86·1	71·4	73·7	83·0	2·3	1·1	2·6
Pershore	324	89·0	85·7	83·4	87·0	3·9	5·4	2·2
Shipston-on-Stour	361	82·1	76·6	71·6	73·7	4·4	12·3	12·5
Stourbridge	3,098	87·2	84·3	83·9	84·5	1·2	1·0	0·9
Tenbury	181	82·2	84·9	85·4	84·5	1·0	—	0·6
Upton-on-Severn	516	85·2	83·9	83·9	80·8	3·3	2·9	5·8
Worcester..	1,274	67·0	71·1	66·9	65·7	1·3	1·7	0·8
	19,840	77·6	72·4	74·4	76·7	2·3	1·9	2·3
YORK, EAST RIDING.								
Beverley	668	81·6	77·1	81·5	79·8	5·0	2·1	3·6
Bridlington	511	70·4	68·3	78·0	76·3	1·2	3·6	5·1
Driffield	452	86·0	76·1	85·0	80·7	3·3	1·6	5·3
Howden	333	83·3	82·7	86·7	83·2	0·9	0·6	1·2
Kingston-upon-Hull	2,628	68·9	52·9	61·4	56·5	4·2	0·8	0·8
Patrington	181	82·6	77·8	90·5	86·2	4·9	1·1	3·9
Pocklington	354	86·8	80·6	85·9	83·6	1·1	1·1	2·5
Sculcoates..	5,565	72·2	73·3	78·9	79·2	7·4	0·8	0·7
Skirlaugh	221	85·1	80·8	83·7	84·6	0·9	0·9	—
York	2,560	80·5	76·3	80·2	78·1	1·4	1·1	1·6
	13,463	75·3	70·6	76·6	74·9	4·6	1·0	1·5

* In the Returns for the years 1893-97 the Number of Certificates of Conscientious Objection finally accounted for," but allowance has been made for these in the "Total Unvaccinated."

IN RESPECTIVE YEARS.

Children not finally accounted for. (3)				Total Unvaccinated. (Col. 2 + Col. 3.)				—
• 1893-97.	1898.	1899.	1900.	• 1893-97.	1898.	1899.	1900.	
								WESTMORLAND.
6·6	7·9	8·1	3·5	6·9	15·5	19·5	14·5	East Ward.
3·1	2·6	2·0	2·0	3·1	4·0	3·3	3·5	Kendal.
4·1	2·6	4·7	4·2	4·1	3·6	8·0	6·3	West Ward.
3·9	3·7	3·6	2·6	4·0	6·4	7·2	6·2	
								WILTS.
7·0	7·0	5·7	2·5	7·0	11·9	13·7	14·8	Amesbury.
20·6	45·9	44·4	35·3	22·1	52·5	49·5	43·0	Bradford-on-Avon.
35·1	28·4	29·9	27·5	37·7	43·1	36·3	39·3	Calne.
30·5	70·1	25·6	34·6	30·5	71·2	34·7	47·5	Chippenham.
46·3	24·1	14·9	9·8	51·6	54·8	37·3	35·7	Cricklade and Wootton Bassett.
26·2	22·8	15·4	8·8	29·9	42·2	35·1	39·4	Devizes.
22·8	42·1	21·0	17·5	23·9	46·2	26·2	27·1	Malmesbury.
2·7	4·1	2·5	1·6	2·9	7·2	5·5	3·2	Marlborough.
6·3	6·9	5·8	10·2	6·3	9·2	10·9	15·3	Mere.
4·1	7·6	3·5	3·4	4·1	10·8	13·6	12·2	Pewsey.
6·5	12·1	5·8	7·7	7·0	24·1	25·8	26·7	Salisbury.
57·1	34·7	16·3	10·1	63·9	73·2	43·9	47·7	Swindon and Highworth.
9·0	20·7	13·7	10·7	9·0	20·7	15·3	11·3	Tisbury.
53·6	38·1	67·3	53·4	59·5	75·2	71·1	66·2	Trowbridge and Melksham.
16·3	9·0	1·9	2·0	17·7	19·0	7·9	8·7	Warminster.
21·0	54·5	30·5	21·8	21·8	61·1	33·4	27·3	Westbury and Whorwellsdown.
7·1	8·4	3·0	1·8	8·1	22·6	18·1	18·5	Wilton.
30·2	30·0	18·6	15·5	33·2	48·7	33·5	35·8	
								WORCESTER.
7·6	7·7	5·8	4·2	7·6	10·1	7·8	7·0	Bromsgrove.
6·1	9·8	6·8	4·0	6·1	10·7	7·4	4·9	Droitwich.
9·5	12·6	9·5	8·0	9·5	13·6	10·5	9·2	Dudley.
16·4	5·5	3·9	2·2	19·1	30·1	23·2	29·0	Evesham.
3·4	3·1	2·9	2·6	3·5	6·7	5·3	5·2	Kidderminster.
23·1	28·5	23·2	18·3	23·4	30·6	24·2	19·5	King's Norton.
6·4	19·3	14·6	4·4	6·4	21·6	15·7	7·0	Martley.
2·8	3·6	3·8	3·4	2·9	7·5	9·2	5·6	Pershore.
9·3	12·0	5·4	3·3	9·6	16·4	17·7	15·8	Shipston-on-Stour.
2·5	3·5	3·1	2·9	2·5	4·7	4·1	3·8	Stourbridge.
8·4	6·5	2·6	6·6	8·5	7·5	2·6	7·2	Tenbury.
6·2	6·7	4·8	4·3	6·2	10·0	7·7	10·1	Upton-on-Severn.
19·2	15·6	16·9	22·4	19·2	16·9	18·6	23·2	Worcester.
11·4	14·2	11·6	9·9	11·6	16·5	13·5	12·2	
								YORK, EAST RIDING.
7·2	4·8	6·2	4·3	7·3	9·8	8·3	7·9	Beverley.
18·2	15·1	7·9	8·6	18·3	16·3	11·5	13·7	Bridlington.
4·0	6·9	4·3	3·3	4·0	10·2	5·9	8·6	Driffield.
4·9	4·6	2·9	1·8	4·9	5·5	3·5	3·0	Howden.
17·5	28·7	26·6	28·3	17·8	32·9	27·4	29·1	Kingston-upon-Hull.
8·6	7·6	1·1	2·8	8·8	12·5	2·2	6·7	Patrington.
3·2	4·9	5·5	2·8	3·2	6·0	6·6	5·3	Pocklington.
14·4	7·0	7·2	6·2	15·5	14·4	8·0	6·9	Sculcoates.
5·6	7·7	3·4	1·4	5·6	8·6	4·3	1·4	Skirlaugh.
7·2	10·3	7·9	8·2	7·2	11·7	9·0	9·8	York.
12·1	12·0	10·8	10·5	12·6	16·6	11·8	12·0	

received in respect of the children born in 1897 has not been included in the Percentages "Not

APP. A, No. 3.

Analysis of Vaccination Officers' Returns, 1893–1900.

—	Number of Births in 1900.	Percentages of Births						
		Certificates of "Successful Vaccination." (1)				Certificates of "Conscientious Objection." (2)		
		1893–97.	1898.	1899.	1900.	1898.	1899.	1900
YORK, NORTH RIDING.								
Aysgarth	108	86·3	89·4	84·0	84·2	—	4·0	—
Bedale	189	88·2	86·4	84·3	87·3	0·4	3·3	3·7
Easingwold	206	85·8	76·2	77·0	78·2	0·4	0·5	0·5
Guisborough	1,430	82·1	79·3	79·7	75·0	2·3	3·7	2·9
Helmsley	113	83·9	90·6	80·1	84·1	1·9	3·1	1·8
Kirkby Moorside	122	81·3	77·7	89·1	81·1	1·8	1·7	5·7
Leyburn	130	89·7	90·2	87·7	86·1	—	0·7	2·3
Malton	529	79·1	75·7	79·7	80·9	3·0	3·8	6·2
Middlesbrough	5,125	81·4	75·5	73·0	70·8	1·3	0·5	0·7
Northallerton	273	88·2	87·1	79·1	85·3	0·9	4·6	4·8
Pickering..	309	75·7	78·2	80·8	79·0	4·6	2·3	2·6
Reeth	52	85·4	87·3	95·4	90·4	—	2·3	1·9
Richmond..	276	80·7	81·0	84·6	85·9	0·3	0·6	0·7
Scarborough	1,282	29·9	26·2	46·1	40·9	41·5	18·0	27·4
Stokesley	260	87·7	83·6	82·8	86·5	0·7	4·0	0·8
Thirsk	328	87·9	73·4	80·4	85·1	0·3	1·9	2·1
Whitby	573	84·9	81·5	80·8	84·5	4·1	3·6	2·6
	11,306	76·4	71·9	73·5	71·8	6·4	3·7	4·7
YORK, WEST RIDING.								
Barnsley	4,181	78·7	75·9	79·8	79·0	0·9	0·8	0·6
Bierley, North	3,088	59·3	59·5	65·8	71·4	4·9	2·0	3·8
Bradford	5,525	55·9	42·1	58·1	66·9	3·0	2·9	5·1
Bramley	2,351	71·9	57·8	79·2	80·4	0·9	2·2	3·2
Dewsbury..	4,357	31·1	34·7	42·1	37·1	13·1	8·5	10·1
Doncaster..	2,691	73·2	71·2	72·9	74·9	4·5	6·5	5·9
Ecclesall Bierlow	5,401	83·4	76·8	79·1	78·8	1·7	1·0	0·8
Goole	846	78·1	76·5	80·6	84·0	0·9	0·4	0·4
Halifax	4,353	5·0	10·1	22·5	19·3	4·3	0·5	0·6
Hemsworth	870	78·6	74·9	75·9	80·9	0·8	1·3	0·8
Holbeck	1,156	80·2	75·3	73·9	75·6	0·6	1·1	1·9
Huddersfield	4,071	87·4	81·3	80·8	83·2	2·0	3·7	3·8
Hunslet	2,732	81·3	77·8	76·6	77·7	1·0	1·9	2·4
Keighley	1,831	2·9	6·1	21·0	25·9	58·6	43·4	53·6
Knaresborough	1,034	55·7	47·9	64·1	60·3	5·2	5·9	6·9
Leeds	7,587	81·6	75·3	72·4	73·1	1·3	1·6	1·8
Ouseburn, Great	231	88·1	84·1	89·5	80·9	1·6	3·6	2·2
Pateley Bridge	201	81·0	55·8	77·8	79·1	0·9	1·3	2·0
Penistone	454	85·6	78·6	82·2	83·7	1·4	0·9	2·0
Pontefract	2,569	80·6	72·6	75·3	80·0	2·2	2·0	1·9
Ripon	363	75·8	89·0	84·2	85·4	0·8	1·8	2·8
Rotherham	4,098	82·1	80·7	83·2	84·2	0·8	1·0	0·8
Saddleworth	393	12·8	35·0	66·6	62·6	46·1	17·2	24·4
Sedbergh	76	89·5	95·7	90·6	86·8	—	1·2	—
Selby	464	86·2	84·3	81·7	88·3	0·7	2·1	1·1
Settle	341	74·7	71·5	77·0	80·6	9·3	7·9	9·1
Sheffield	8,154	77·3	73·4	78·4	79·7	1·2	1·0	0·7
Skipton	1,147	25·5	26·7	48·2	42·0	44·1	18·6	30·7
Tadcaster	948	84·5	79·4	87·1	85·2	1·7	1·3	0·9
Thorne	445	72·9	61·9	64·4	71·0	5·4	5·0	5·4
Wakefield	3,618	80·3	80·1	83·0	83·7	1·4	1·6	1·8
Wetherby	345	82·7	85·7	83·8	83·5	0·8	1·0	2·6
Wharfedale	1,396	69·6	62·0	72·8	78·3	5·7	3·9	3·2
Wortley	1,651	80·1	79·6	78·4	78·9	0·6	1·1	0·9
	78,965	66·6	63·2	69·0	70·4	5·1	3·6	4·3

* In the Returns for the years 1893-97 the Number of Certificates of Conscientious Objection finally accounted for," but allowance has been made for these in the "Total Unvaccinated."

APP. A, No. 3.

Analysis of Vaccination Officers' Returns, 1893–1900.

IN RESPECTIVE YEARS.

Children not finally accounted for. (3)				Total Unvaccinated. (Col. 2 + Col. 3.)				—
* 1893–97.	1898.	1899.	1900.	* 1893–97.	1898.	1899.	1900.	
								YORK, NORTH RIDING.
3·2	3·8	4·0	3·7	3·2	3·8	8·0	3·7	Aysgarth.
3·2	5·3	4·8	1·6	3·2	5·7	8·1	5·3	Bedale.
5·7	12·7	13·5	14·1	5·7	13·1	14·0	14·6	Easingwold.
7·4	8·0	5·2	11·7	7·4	10·3	8·9	14·6	Guisborough.
9·0	1·9	6·9	5·3	9·0	3·8	10·0	7·1	Helmsley.
8·6	3·6	3·3	4·1	8·6	5·4	5·0	9·8	Kirkby Moorside.
2·3	1·8	4·1	0·8	2·3	1·8	4·8	3·1	Leyburn.
9·3	11·5	5·5	3·6	9·7	14·5	9·3	9·8	Malton.
6·2	9·5	10·9	12·9	6·2	10·8	11·4	13·6	Middlesbrough.
2·9	3·8	5·0	2·9	2·9	4·7	9·6	7·7	Northallerton.
10·2	6·8	6·9	6·8	10·9	11·4	9·2	9·4	Pickering.
7·9	4·8	—	1·9	7·9	4·8	2·3	3·8	Reeth.
8·4	9·0	4·6	6·9	8·5	9·3	5·2	7·6	Richmond.
56·9	27·6	21·8	18·9	57·0	62·1	39·8	46·3	Scarborough.
3·5	7·7	2·2	4·6	3·5	8·4	6·2	5·4	Stokesley
2·7	16·0	7·1	3·7	2·7	16·3	9·0	5·8	Thirsk.
6·3	3·6	4·0	3·3	6·5	7·7	7·6	5·9	Whitby.
12·3	10·0	9·7	10·9	12·4	16·4	13·4	15·6	
								YORK, WEST RIDING.
8·3	8·8	6·1	7·2	8·3	9·7	6·9	7·8	Barnsley.
28·0	23·4	18·7	15·1	28·7	28·3	20·7	18·9	Bierley, North.
29·5	40·6	24·9	16·8	29·7	43·6	27·8	21·9	Bradford.
18·4	27·1	5·3	4·8	18·4	28·0	7·5	8·0	Bramley.
51·4	37·1	34·8	38·9	51·4	50·2	43·3	49·0	Dewsbury.
13·8	9·8	5·8	4·8	14·2	14·3	12·3	10·7	Doncaster.
4·6	7·1	6·3	6·8	4·7	8·8	7·3	7·6	Ecclesall Bierlow.
10·6	9·3	5·2	5·4	10·6	10·2	5·6	5·8	Goole.
82·1	71·7	63·1	68·1	82·8	76·0	63·6	68·7	Halifax.
9·6	11·7	10·0	7·0	9·7	12·5	11·8	7·8	Hemsworth.
5·7	10·5	8·4	8·4	5·7	11·1	9·5	10·3	Holbeck.
2·8	6·8	4·4	4·4	2·8	8·8	8·1	8·2	Huddersfield.
5·6	7·1	7·2	6·1	5·6	8·1	9·1	8·5	Hunslet.
75·7	30·7	24·8	9·2	86·8	89·3	68·2	62·8	Keighley.
32·0	33·4	18·7	20·6	32·5	38·6	24·6	27·5	Knaresborough.
6·7	10·6	13·2	12·1	6·7	11·9	14·8	13·9	Leeds.
2·8	4·1	0·8	3·5	2·9	5·7	4·4	5·7	Ouseburn, Great.
10·7	28·8	13·7	13·9	10·9	29·7	15·0	15·9	Pateley Bridge.
6·5	11·6	8·0	5·5	6·7	13·0	8·9	7·5	Penistone.
7·1	10·4	9·0	5·4	7·1	12·6	11·0	7·3	Pontefract.
14·6	3·4	3·4	3·3	14·7	4·2	5·2	6·1	Ripon.
7·0	5·6	4·1	3·4	7·0	6·4	5·1	4·2	Rotherham.
65·5	7·9	5·8	6·1	76·3	54·0	23·0	30·5	Saddleworth.
3·4	1·4	1·2	3·9	3·4	1·4	2·4	3·9	Sedbergh.
4·6	3·0	2·5	2·2	4·6	3·7	4·6	3·3	Selby.
14·7	9·6	7·6	4·4	15·9	18·9	15·5	13·5	Settle.
0·1	9·2	5·8	6·2	9·2	10·4	6·8	6·9	Sheffield.
52·7	16·4	21·0	17·6	61·8	60·5	39·6	48·3	Skipton.
5·5	7·4	3·0	3·4	5·5	9·1	4·3	4·3	Tadcaster.
17·0	20·3	18·6	14·2	17·5	26·7	23·6	19·6	Thorne.
7·5	5·8	3·5	3·6	7·5	7·2	5·1	5·4	Wakefield.
7·9	6·0	3·6	1·4	7·9	6·8	4·6	4·0	Wetherby.
19·1	23·3	12·6	9·9	19·7	29·0	16·5	13·1	Wharfedale.
9·4	8·4	8·3	7·5	9·4	9·0	9·4	8·4	Wortley.
20·6	18·5	14·3	13·2	21·2	23·6	17·9	17·5	

received in respect of the children born in 1897 has not been included in the Percentages "Not

APP. A, No. 3.

Analysis of Vaccination Officers' Returns, 1893-1900.

—	Number of Births in 1900.	Percentages of Births: Certificates of "Successful Vaccination." (1) 1893-97.	1898.	1899.	1900.	Certificates of "Conscientious Objection." (2) 1898.	1899.	1900.
ANGLESEY.								
Anglesey	321	86·2	89·3	86·9	87·2	2·3	0·3	—
Holyhead	532	86·5	85·9	85·6	85·7	—	—	—
	853	86·4	87·2	86·1	86·3	0·9	0·1	—
BRECKNOCK.								
Brecknock	391	87·7	87·8	85·5	88·0	—	0·2	0·3
Builth	221	85·0	85·4	80·2	84·6	0·4	1·3	0·9
Crickhowell	689	77·1	62·9	65·2	87·6	0·5	1·0	1·0
Hay	203	69·0	73·4	78·2	74·9	5·2	5·8	6·4
	1,504	79·6	74·3	75·1	85·6	1·1	1·5	1·5
CARDIGAN.								
Aberayron	213	86·7	82·0	84·6	81·7	—	—	0·5
Aberystwith	454	84·2	83·7	84·1	83·0	0·8	2·5	1·3
Cardigan	309	75·6	81·0	85·7	87·4	2·6	1·9	2·3
Lampeter	209	85·9	85·3	82·5	88·0	—	—	—
Tregaron	177	88·4	88·2	84·1	87·0	—	—	—
	1,362	83·4	83·7	84·3	85·1	0·9	1·2	1·0
CARMARTHEN.								
Carmarthen	816	88·0	87·9	87·0	88·7	0·4	0·1	0·2
Llandilo Fawr	750	86·4	86·9	85·7	88·7	—	0·3	—
Llandovery	219	87·7	88·8	81·9	86·7	—	—	—
Llanelly	1,804	84·4	85·3	83·4	87·7	0·1	0·5	0·2
Newcastle-in-Emlyn	417	87·3	82·2	85·2	86·8	0·2	0·2	0·5
	4,006	86·0	86·0	84·7	88·0	0·2	0·3	0·3
CARNARVON.								
Bangor and Beaumaris ..	987	86·3	84·4	85·3	88·0	0·3	1·1	0·3
Carnarvon	1,170	77·7	76·6	84·9	86·9	—	0·8	0·3
Conway	843	81·3	74·0	79·8	82·8	0·1	0·5	0·8
Pwllheli	444	83·0	69·0	77·6	86·7	0·4	0·2	0·2
	3,449	81·9	77·1	82·8	86·2	0·2	0·5	0·4
DENBIGH.								
Llanrwst	348	80·1	75·4	78·2	82·8	2·1	—	—
Ruthin	263	86·2	85·5	87·9	88·6	—	—	—
Wrexham	2,496	84·5	82·8	85·0	85·7	0·2	0·3	0·3
	3,107	84·2	82·2	84·5	85·6	0·4	0·2	0·3

* In the Returns for the years 1893-97 the Number of Certificates of Conscientious Objection finally accounted for," but allowance has been made for these in the "Total Unvaccinated."

IN RESPECTIVE YEARS.

APP. A, No. 3.

Analysis of Vaccination Officers' Returns, 1893-1900.

Children not finally accounted for. (3)				Total Unvaccinated. (Col. 2 + Col. 3.)				
* 1893-97.	1898.	1899.	1900.	* 1893-97.	1898.	1899.	1900.	—
								ANGLESEY.
3·6	3·1	1·2	2·2	3·6	5·4	1·5	2·2	Anglesey.
5·4	6·3	4·2	4·3	5·4	6·3	4·2	4·3	Holyhead.
4·7	5·0	3·1	3·5	4·7	5·9	3·2	3·5	
								BRECKNOCK.
2·6	3·0	3·1	3·6	2·6	3·0	3·3	3·9	Brecknock.
4·6	5·2	9·1	7·2	4·6	5·6	10·4	8·1	Builth.
12·8	30·7	22·0	4·2	12·8	31·2	23·0	5·2	Crickhowell.
19·2	12·4	4·4	8·4	19·5	17·6	10·2	14·8	Hay.
10·1	16·8	12·1	5·1	10·2	17·9	13·6	6·6	
								CARDIGAN.
3·1	7·6	3·4	6·6	3·1	7·5	3·4	6·1	Aberayron.
5·5	4·7	4·0	5·1	5·5	5·5	6·5	6·4	Aberystwith.
15·9	8·0	3·5	2·3	15·9	10·6	5·4	4·6	Cardigan.
2·1	2·6	1·8	2·4	2·1	2·6	1·8	2·4	Lampeter.
2·2	1·9	1·5	2·8	2·2	1·9	1·5	2·8	Tregaron
6·6	5·3	3·1	3·8	6·6	6·2	4·3	4·8	
								CARMARTHEN.
2·3	0·6	1·5	1·1	2·3	1·0	1·6	1·3	Carmarthen.
3·3	2·4	1·6	0·7	3·3	2·4	1·9	0·7	Llandilo Fawr.
2·7	2·3	1·3	0·9	2·7	2·3	1·3	0·9	Llandovery.
5·3	3·6	2·7	2·7	5·3	3·7	3·2	2·0	Llanelly.
2·8	6·9	2·0	4·3	2·8	7·1	2·2	4·8	Newcastle-in-Emlyn.
3·9	3·0	2·1	2·0	3·9	3·2	2·4	2·2	
								CARNARVON.
3·8	2·6	2·0	0·6	3·8	2·9	3·1	0·9	Bangor and Beaumaris.
10·2	9·5	3·2	1·8	10·2	9·5	4·0	2·1	Carnarvon.
6·8	15·1	7·4	3·5	6·8	15·2	7·9	4·3	Conway.
6·2	19·4	6·9	3·4	6·2	19·8	7·1	3·6	Pwllheli.
6·9	10·3	4·3	2·1	6·9	10·5	4·8	2·5	
								DENBIGH.
7·9	15·4	7·8	4·9	8·0	17·5	7·8	4·9	Llanrwst.
2·9	4·2	1·5	2·3	2·9	4·2	1·5	2·3	Ruthin.
4·3	4·5	3·5	3·1	4·8	4·7	3·8	3·4	Wrexham.
4·9	5·7	3·8	3·3	4·9	6·1	4·0	3·6	

received in respect of the children born in 1897 has not been included in the Percentages * Not

App. A. No. 3.

Analysis of Vaccination Officers' Returns, 1893–1900.

—	Number of Births in 1900.	Percentages of Births: Certificates of "Successful Vaccination." (1) 1893–97.	1898.	1899.	1900.	Certificates of "Conscientious Objection." (2) 1898.	1899.	1900.
FLINT.								
Asaph, St.	688	81·9	78·7	81·0	84·3	0·3	—	0·3
Hawarden	588	78·2	87·2	88·6	88·1	0·2	0·4	0·2
Holywell	1,179	84·0	82·6	85·1	86·0	0·3	—	—
	2,455	82·2	82·4	84·6	86·0	0·2	0·1	0·1
GLAMORGAN.								
Bridgend and Cowbridge ..	2,128	82·8	80·1	75·0	78·4	0·3	0·4	0·4
Cardiff	7,308	80·7	72·1	71·1	75·8	1·4	1·6	2·0
Gower	338	80·5	83·3	78·4	85·5	0·3	0·6	0·3
Merthyr Tydfil	4,960	82·3	78·1	71·8	78·2	0·3	0·6	0·6
Neath	2,442	87·2	85·3	79·9	82·6	0·5	0·8	0·7
Pontardawe	938	87·9	88·1	87·7	87·5	0·1	—	0·3
Pontypridd	7,679	80·3	73·5	65·8	72·8	0·3	0·4	0·4
Swansea	3,586	81·7	83·1	79·6	80·4	0·2	0·4	0·6
	29,377	82·3	77·1	72·6	77·2	0·6	0·8	0·9
MERIONETH.								
Bala	129	79·7	81·7	70·1	76·0	1·5	—	1·6
Corwen	408	82·6	84·4	87·1	83·6	0·4	0·9	0·3
Dolgelly	326	84·6	84·1	88·4	89·0	0·3	0·3	0·3
Festiniog	820	81·9	54·7	73·2	69·5	—	0·1	—
	1,683	83·5	69·9	79·4	77·2	0·3	0·4	0·2
MONTGOMERY.								
Forden	362	85·2	88·1	86·6	87·0	1·4	0·3	1·4
Llanfyllin	427	87·6	87·6	89·1	91·3	0·2	0·4	0·2
Machynlleth	260	88·3	87·2	83·9	81·2	0·4	—	—
Newtown and Llanidloes ..	570	84·7	79·8	78·3	79·1	0·5	0·2	0·5
	1,619	86·1	84·8	84·1	84·9	0·6	0·2	0·6
PEMBROKE.								
Haverfordwest	865	77·5	72·7	79·6	80·8	—	0·2	0·1
Narberth	396	87·9	88·4	92·0	93·4	0·2	—	—
Pembroke	819	85·9	82·6	83·5	87·2	0·3	0·5	0·1
	2,030	82·8	79·5	83·4	85·7	0·2	0·3	0·1
RADNOR.								
Knighton	315	35·3	57·3	78·5	69·8	0·9	3·6	4·1
Rhayader	248	74·4	61·0	47·5	39·1	0·8	0·7	0·4
	563	50·5	58·9	63·6	56·3	0·8	2·2	2·5

* In the Returns for the years 1893–97 the Number of Certificates of Conscientious Objection finally accounted for," but allowance has been made for these in the "Total Unvaccinated."

IN RESPECTIVE YEARS.

Children not finally accounted for. (3)				Total Unvaccinated. (Col. 2 + Col. 3.)				—
* 1893-97.	1898.	1899.	1900.	* 1893-97.	1898.	1899.	1900.	
								FLINT.
7·5	7·0	4·3	4·2	7·5	7·3	4·3	4·5	Asaph, St.
13·8	2·5	3·7	2·6	13·8	2·7	4·1	2·8	Hawarden.
6·5	7·7	5·5	4·4	6·5	8·0	5·5	4·4	Holywell.
8·3	6·4	4·7	3·9	8·3	6·6	4·8	4·0	
								GLAMORGAN.
5·1	8·1	10·8	12·0	5·1	8·4	11·2	12·4	Bridgend and Cowbridge.
8·2	14·9	13·0	12·6	8·2	16·3	14·6	14·6	Cardiff.
11·9	8·0	10·2	4·1	11·9	8·3	10·8	4·4	Gower.
5·8	8·2	10·0	9·5	5·8	8·5	10·6	10·1	Merthyr Tydfil.
2·8	4·3	7·3	6·4	2·8	4·8	8·1	7·1	Neath.
2·2	2·0	1·2	1·4	2·2	2·1	1·2	1·7	Pontardawe.
6·3	13·0	14·8	13·0	6·3	13·3	15·2	13·4	Pontypridd.
5·3	5·7	8·0	7·7	5·3	5·9	8·4	8·3	Swansea.
6·1	10·3	11·3	10·6	6·1	10·9	12·1	11·5	
								MERIONETH.
7·2	8·4	13·4	12·4	7·2	9·9	13·4	14·0	Bala.
6·9	5·1	4·1	5·4	6·9	5·5	5·0	5·7	Corwen.
2·8	3·5	2·1	2·5	2·8	3·8	2·4	2·8	Dolgelly.
5·0	33·2	11·8	19·0	5·0	33·2	11·9	19·0	Festiniog.
5·2	18·5	8·1	12·0	5·2	18·8	8·5	12·2	
								MONTGOMERY.
5·1	1·9	2·1	2·5	5·1	3·3	2·4	3·9	Forden.
3·2	3·7	1·3	1·2	3·2	3·9	1·7	1·4	Llanfyllin.
3·5	6·4	4·2	3·8	3·5	6·3	4·2	3·8	Machynlleth.
7·0	10·2	11·3	9·5	7·0	10·7	11·5	10·0	Newtown and Llanidloes.
5·0	6·1	5·3	4·8	5·0	6·7	5·5	5·4	
								PEMBROKE.
10·7	15·2	7·8	7·2	10·7	15·2	8·0	7·3	Haverfordwest.
3·8	1·9	1·8	0·5	3·8	2·1	1·8	0·5	Narberth.
4·3	8·5	6·4	4·4	4·3	8·8	6·9	4·5	Pembroke.
6·9	10·0	6·2	4·8	6·9	10·2	6·5	4·9	
								RADNOR.
51·9	33·8	10·9	15·2	51·9	34·7	14·5	19·3	Knighton.
16·4	30·3	45·7	50·4	16·6	31·1	46·4	50·8	Rhayader.
33·1	32·3	27·6	30·7	33·2	33·1	29·8	33·2	

received in respect of the children born in 1897 has not been included in the Percentages "Not

No. 4.

APP. A, No. 4.
On the Administration of the Vaccination Acts from 1873 to 1900; by Mr. Huddart.

On the ADMINISTRATION of the VACCINATION ACTS in ENGLAND and WALES during the twenty-eight years 1873–1900: an illustrated Statistical Summary; by Mr. CHAS. J. HUDDART.

Nothing more is attempted here than the statement in brief form of certain data in connexion with the administration of the Vaccination Acts in England and Wales. The data have been taken from the Returns of Vaccination Officers as issued in the Annual Reports of the Board and their Medical Officer, and have been incorporated in a series of twelve maps of the country in a way to give, county by county, for England and for North and South Wales, the following information during each of the five quinquennia 1873–97 and for each of the three succeeding years. For the sake of uniformity of nomenclature, North and South Wales are each of them treated as a "county."

The maps are designed to illustrate :—

I.–V. The percentages of default under the Vaccination Acts in respect of the five quinquennia 1873–97.

VI. Like facts for the year 1898.

VII. The percentages of "abstention" from vaccination for the same year, 1898—arrived at by the addition to the "default" of map VI. of the children legally exempted from vaccination under Section 2 of the Act of 1898.

VIII.–IX. Facts as to such "abstention" for the years 1899 and 1900.

X.–XII. Percentages of statutory "exemption" from vaccination in respect of 1898, 1899, and 1900.

In order that these maps may be the more readily interpreted, there has been placed over against each a "key" showing the numerical position of the counties in the order of growing default, abstention, and exemption respectively.

It will be seen from map I., dealing with the period 1873–77, that of the 45 counties only six showed upwards of 5 per cent. of default, whilst not one county reached 10 per cent. of default. Hence, it seems clear that, whatever the cause, the Vaccination Acts were as regards these five years working smoothly and successfully. And it may be noted here that not one of the six counties just referred to reached 25 per cent. of default in any of the five quinquennia ended with 1897.

Map II. shows that in the second period, 1878-82, only one county, Leicester, had default of upwards of 10 per cent. Here again is evidence of all but universal smoothness of working of the Acts.

Once again, in Map III., for the quinquenniad 1883–87, Leicester alone figured with upwards of 10 per cent. of default. That county had indeed made large retrogression in the period, its default having grown from 12·0 in Map II. to as much as 27·5 per cent. The other notable change in Map III. is the addition of nine counties to those previously having upwards of 5 per cent. of default, some of the counties thus added becoming in later times notorious centres of the anti-vaccination movement.

Not until the fourth quinquenniad is arrived at, Map IV., 1888-92—during nearly the whole of which the Royal Commission on Vaccination was sitting, and public attention was directed to the more or less organised opposition to vaccination—is there found any great falling off in the amount of vaccination as compared with the earlier fifteen years. Even so, all but three counties had under 20 per cent. of default, Bedford, North Hants, and Leicester alone being prominently neglectful of vaccination; while no fewer than twenty-six counties had under 10 per cent. of default.

In the period 1893–97, Map V., many boards of guardians were still admittedly doing nothing to aid, rather many were actively hindering, the local administrative officers; while during the bulk of the period the Royal Commission on Vaccination continued sitting. Nevertheless, there were twenty-seven counties which showed over 80 per cent. of births as finally accounted for under the Vaccination Acts, and only ten counties had default of upwards of 25 per cent.

It is not without interest to note that during the whole period of twenty-five years covered by Maps I.-V., notable default was limited to seven counties, namely, Leicester, 1878–82; Leicester, 1883–87; Bedford, North Hants, Leicester, 1888–92; Notts, Wilts, Gloucester, Derby, North Hants, Bedford, and Leicester, 1893–97.

Map VI. deals with default in the first year during any part of which the Vaccination Act of 1898 was in force. For four months of that year parents of children of all ages could, by fulfilling the requirements of Section 2 of the Act, secure exemption from the penal clauses of the Act of 1867. Map VI. shows that as regards the year 1898 there were twenty-seven counties having less than 20 per cent. and only eleven counties with upwards of 25 per cent. of "default" under the Acts.

With a view, however, of showing what was the exact quantity of "abstention" from vaccination as regards that year—the amount, namely, of "default" and "exemption" in combination—Map VII. has been prepared. In that map it is seen that fifteen counties of the first twenty-seven in Map VI. still figure with abstentions amounting to less than 20 per cent. of registered births, and that as many as twenty-five counties are found to have less than four exemptions per cent. of births. Moreover, there are found only eighteen counties showing abstention of upwards of 25 per cent. of births, inclusive that is of exemptions. Nevertheless, notable amount of "exemption" is observed in the case of

some counties, *e.g.*, Dorset (where "default" of 8·2 grew into 22·1 per cent. of "abstention"); Oxon (11·1 grown to 22·4); Bucks (17·1 grown to 30·1); Lincs (15·1 grown to 31·8); Norfolk (13·9 grown to 32·3); Wilts (30·0 grown to 48·7); North Hants (33·0 grown to 66·2); and Leicester (47·5 grown to 75·9 per cent). Of these counties, Dorset alone has in any large degree since ceased to claim exemption.

Coming to Map VIII. in regard of the year 1899, the first complete year of operation of the new Act, it is found that the novelty of Section 2 is in less favour, as twenty-seven counties had under 20 per cent. of abstention from vaccination and only eleven counties had upwards of 25 per cent. The counties showing over 30 per cent. were only seven in number.

In respect of 1900, Map IX., as many as twenty-eight counties had less than 20 per cent. and only ten had more than 25 per cent. of abstention. No more than six counties had upwards of 30 per cent. of abstention.

Looking to the Returns of Vaccination Officers on the general question of growth or decline of vaccination, and leaving out of count all reference to re-vaccination, the following data under the present law are all that need be here mentioned, namely :—

(*a.*) Of the 923,059 children whose births were registered in 1898 as many as 562,737 were returned as ascertained to have been vaccinated by February, 1900, the date when the Returns reached the Board, whilst the total number of certificates of successful primary vaccination received by Vaccination Officers in 1899 amounted to 696,151, or 133,414 of children whose births were registered in other years, large arrears of vaccination having accumulated during some years under lax administration of the law in many unions.

(*b.*) Of the 929,189 children whose births were registered in 1899 there were 617,113 ascertained to be vaccinated by February, 1901, whilst the total of successful primary vaccinations recorded by Vaccination Officers in 1900, was 687,442, or 70,329 of children whose births had been registered in other years, and this in the face of a less amount of arrears of vaccination to be drawn upon.

(*c.*) Of the 927,222 children whose births were registered in 1900 there were 636,940 ascertained to be vaccinated by February, 1902, whilst the total of successful primary vaccination certificates received by Vaccination Officers in 1901 amounted to 723,437, or 76,497 of children whose births were registered in other years.

As regards the amount of exemption recorded in the country generally, a Parliamentary Return, No 89, of March 7th, 1899, showed 230,147 certificates to have been received by Vaccination Officers between August 12th and December 31st, 1898, in respect of children of *all ages*, under the special terms of the Act of that

year. In regard of children whose births were registered in 1898, Vaccination Officers received 47,423 certificates of exemption, equal to 5·1 per cent. of births. In regard of 1899, they received 33,573 certificates, equal to 3·6 per cent. of registered births; and in respect of 1900, they received 39,693 certificates of exemption, equal to 4·3 per cent. of registered births.

Turning to the three concluding maps, X.–XII., which deal exclusively with exemption data for the three years 1898–1900, it will be seen that twenty-seven, thirty, and twenty seven counties respectively had less than 5 per cent. of total registered children exempted. In only one year, 1898, did as many as eleven counties claim exemption for upwards of 10 per cent. of births.

That the twenty-seven counties claiming exemption for less than 5 per cent. of children registered in 1900 were of notable population may be gathered from the fact that they had among them no less than 764,491 of the total 927,222 births registered in the year. They were in number 60·0 per cent. of the total of 45 counties, while their births were 82·4 per cent. of the registered total.

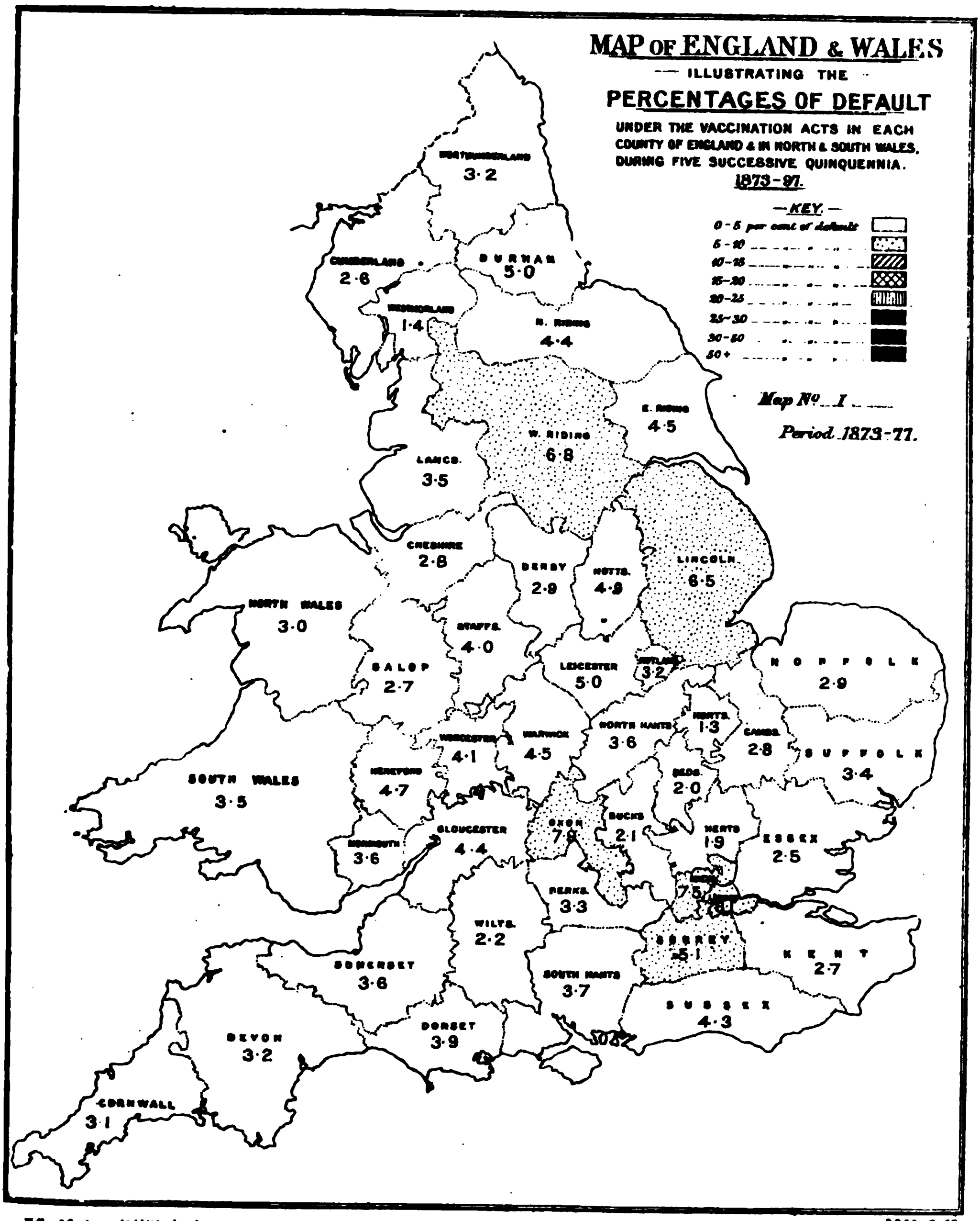
MAP I.

Showing PERCENTAGES on REGISTERED BIRTHS of DEFAULT under the VACCINATION ACTS in respect of the Period 1873–77.

COUNTIES in ORDER of DEFAULT.

Division I.						Division II.		
0–5 per cent.						5–10 per cent.		
1.	Huntingdonshire ..	1·3	21.	Suffolk	3·4	40.	Surrey	5·1
2.	Westmorland ..	1·4	22.	Lancashire	3·5	41.	Lincolnshire ..	6·5
3.	Hertfordshire ..	1·9		South Wales ..	3·5	42.	West Riding ..	6·8
4.	Bedfordshire ..	2·0	24.	Monmouthshire ..	3·6	43.	Middlesex	7·5
5.	Buckinghamshire ..	2·1		North Hants ..	3·6	44.	Oxfordshire ..	7·9
6.	Wiltshire	2·2		Somersetshire ..	3·6	45.	London	8·1
7.	Essex	2·5	27.	South Hants ..	3·7		(6 *Counties.*)	
8.	Cumberland.. ..	2·6	28.	Dorsetshire	3·9			
9.	Kent	2·7	29.	Staffordshire ..	4·0			
	Salop	2·7	30.	Worcestershire ..	4·1			
11.	Cambridgeshire ..	2·8	31.	Sussex	4·3			
	Cheshire	2·8	32.	Gloucestershire ..	4·4			
13.	Derbyshire	2·9		North Riding ..	4·4			
	Norfolk	2·9	34.	East Riding.. ..	4·5			
15.	North Wales.. ..	3·0		Warwickshire ..	4·5			
16.	Cornwall	3·1	36.	Herefordshire ..	4·7			
17.	Devonshire	3·2	37.	Nottinghamshire..	4·9			
	Northumberland ..	3·2	38.	Durham	5·0			
	Rutlandshire ..	3·2		Leicestershire ..	5·0			
20.	Berkshire	3·3						
	(39 *Counties.*)							

As indicative of the population represented in Division I., it may be stated that of the total of 887,947 births registered in the concluding year of the quinquennium (1877) those counties registered 636,485 births, or 71·7 per cent. of the whole.



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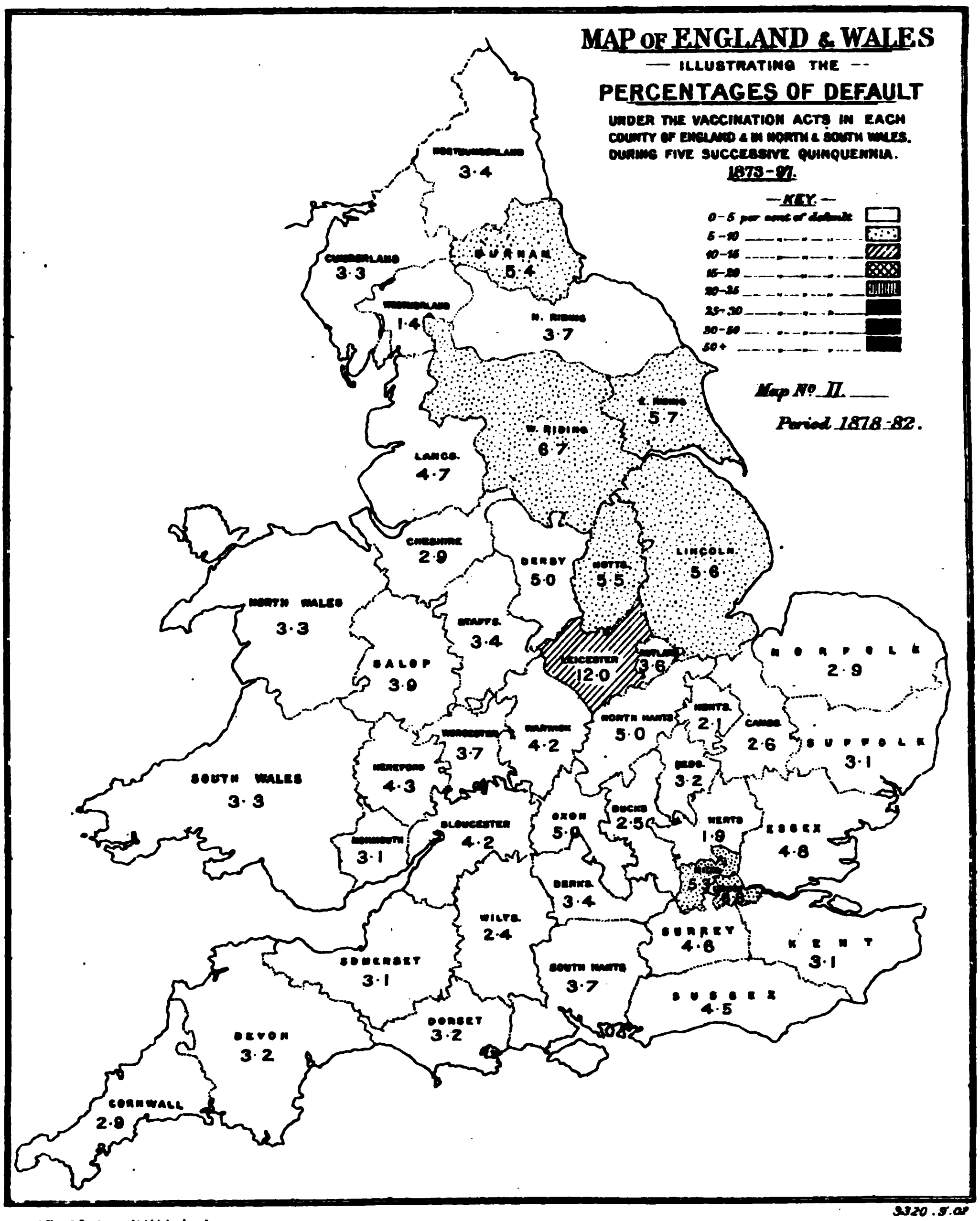

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MAP II.

Showing PERCENTAGES on REGISTERED BIRTHS of DEFAULT under the VACCINATION ACTS in respect of the Period 1878–82.

COUNTIES in ORDER of DEFAULT.

Division I.						Division II.			Division III.		
0–5 per cent.						5–10 per cent.			10–15 per cent.		
1.	Westmorland.	1·4	20.	Berks	3·4	38.	Middlesex	5·3	45.	Leicester	12·0
2.	Herts	1·9		Northumberland.	3·4	39.	Durham	5·4		(1 *County.*)	
3.	Hunts	2·1		Staffs	3·4	40.	Notts	5·5			
4.	Wilts..	2·4	23.	Rutland	3·6	41.	Lincs	5·6			
5.	Bucks	2·5	24.	S. Hants	3·7	42.	E. Riding	5·7			
6.	Cambridge	2·6		Worcester	3·7	43.	W. Riding	6·7			
7.	Chester	2·9		N. Riding	3·7	44.	London	6·8			
	Cornwall	2·9	27.	Salop	3·9		(7 *Counties.*)				
	Norfolk	2·9	28.	Gloucester	4·2						
10.	Kent	3·1		Warwick	4·2						
	Monmouth	3·1	30.	Hereford	4·3						
	Somerset	3·1	31.	Sussex	4·5						
	Suffolk	3·1	32.	Surrey	4·6						
14.	Bedford	3·2	33.	Lancs	4·7						
	Devon	3·2	34.	Essex	4·8						
	Dorset	3·2	35.	Derby	5·0						
17.	Cumberland	3·3		N. Hants	5·0						
	N. Wales	3·3		Oxon	5·0						
	S. Wales	3·3									
(37 *Counties.*)											

In the counties figuring in Division I. there were in 1882, the last year of the period, 577,218, equal to 64·9 per cent. of the total of 889,082 births registered in the country generally during that year. Of the remaining eight counties only three find place as regards the year 1900 among those which had upwards of 25 per cent. of "abstention from vaccination.'

MAP III.

Showing PERCENTAGES on REGISTERED BIRTHS of DEFAULT under the VACCINATION ACTS in respect of the Period 1883–87.

COUNTIES in ORDER of DEFAULT.

Division I. — 0–5 per cent.

No.	County	Per cent.
1.	Westmorland	1·4
2.	Hunts	1·8
3.	Worcester	2·6
4.	Cambridge	2·9
5.	Chester	3·2
6.	Northumberland	3·3
	Salop	3·3
	N. Wales	3·3
9.	Bucks	3·4
	S. Wales	3·4
11.	Rutland	3·5
12.	Herts	3·6
	Wilts	3·6
14.	Cornwall	3·7
15.	Monmouth	3·8
16.	Devon	3·9
	Hereford	3·9
	Staffs	3·9
	N. Riding	3·9
20.	Cumberland	4·0
21.	Norfolk	4·1
22.	Somerset	4·3
23.	Berks	4·4
	Dorset	4·4
	Suffolk	4·4
26.	Kent	4·6
	S. Hants	4·6
28.	Warwick	4·8

(28 *Counties*.)

Division II. — 5–10 per cent.

No.	County	Per cent.
29.	Lincs	5·2
	Surrey	5·2
31.	Durham	5·5
32.	Oxon	5·9
	Sussex	5·9
34.	Lancs	6·0
35.	Gloucester	6·3
36.	Derby	6·6
37.	Essex	7·0
	E. Riding	7·0
39.	Notts	7·1
40.	London	7·4
41.	Bedford	8·3
42.	W. Riding	8·6
43.	Middlesex	8·7
44.	N. Hants	8·8

(16 *Counties*.)

Division III. — 10–15 per cent.

Nil.

Division IV. — 15–20 per cent.

Nil.

Division V. — 20–25 per cent.

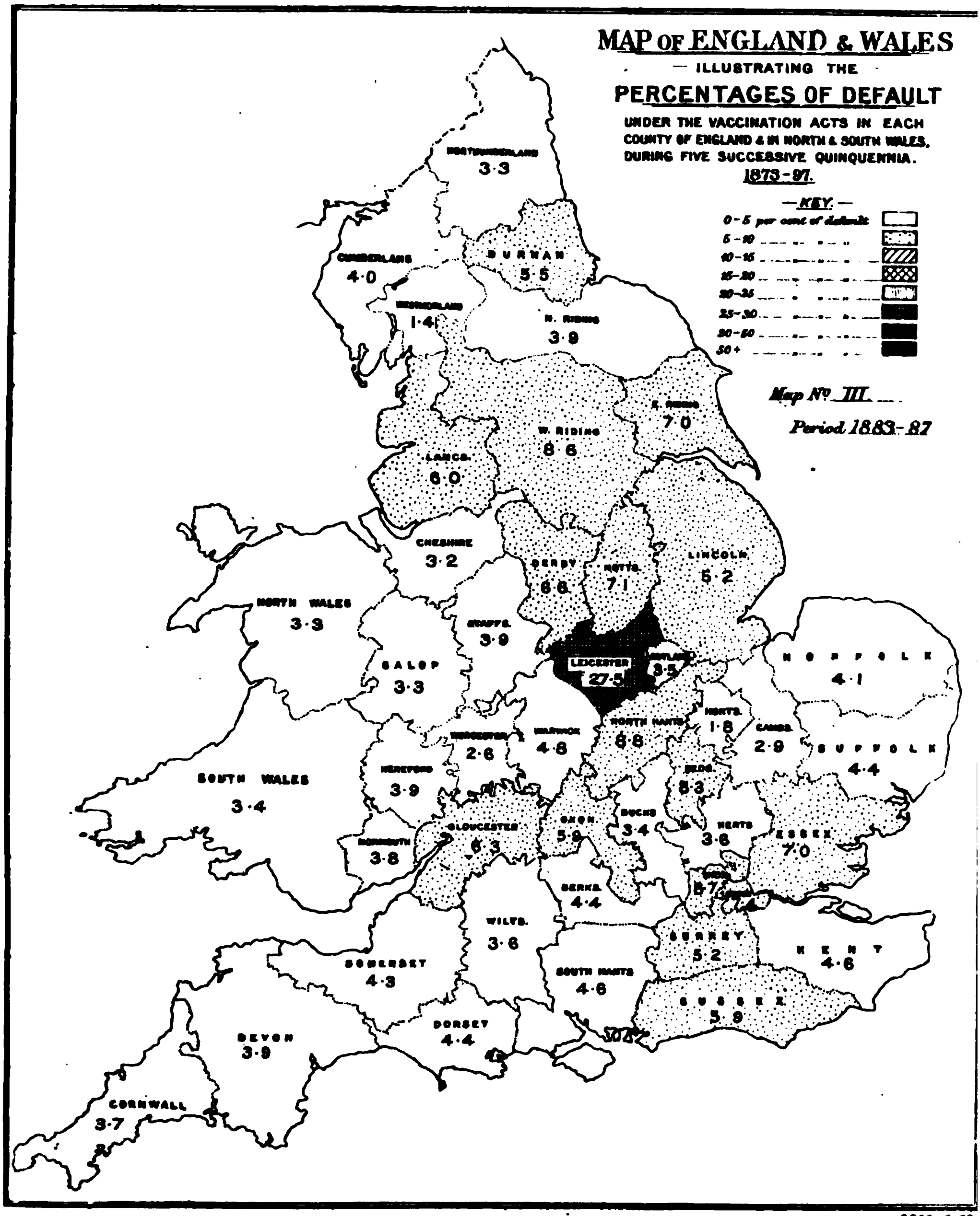
Nil.

Division VI. — 25–30 per cent.

No.	County	Per cent.
45.	Leicester	27·5

(1 *County*.)

The counties in Divisions I. and II. had among them 98·7 per cent. of the births registered in 1887, the concluding year of the period. Of the sixteen counties of Division II. only nine find place in 1900 among those showing upwards of 25 per cent. of "abstention from vaccination."



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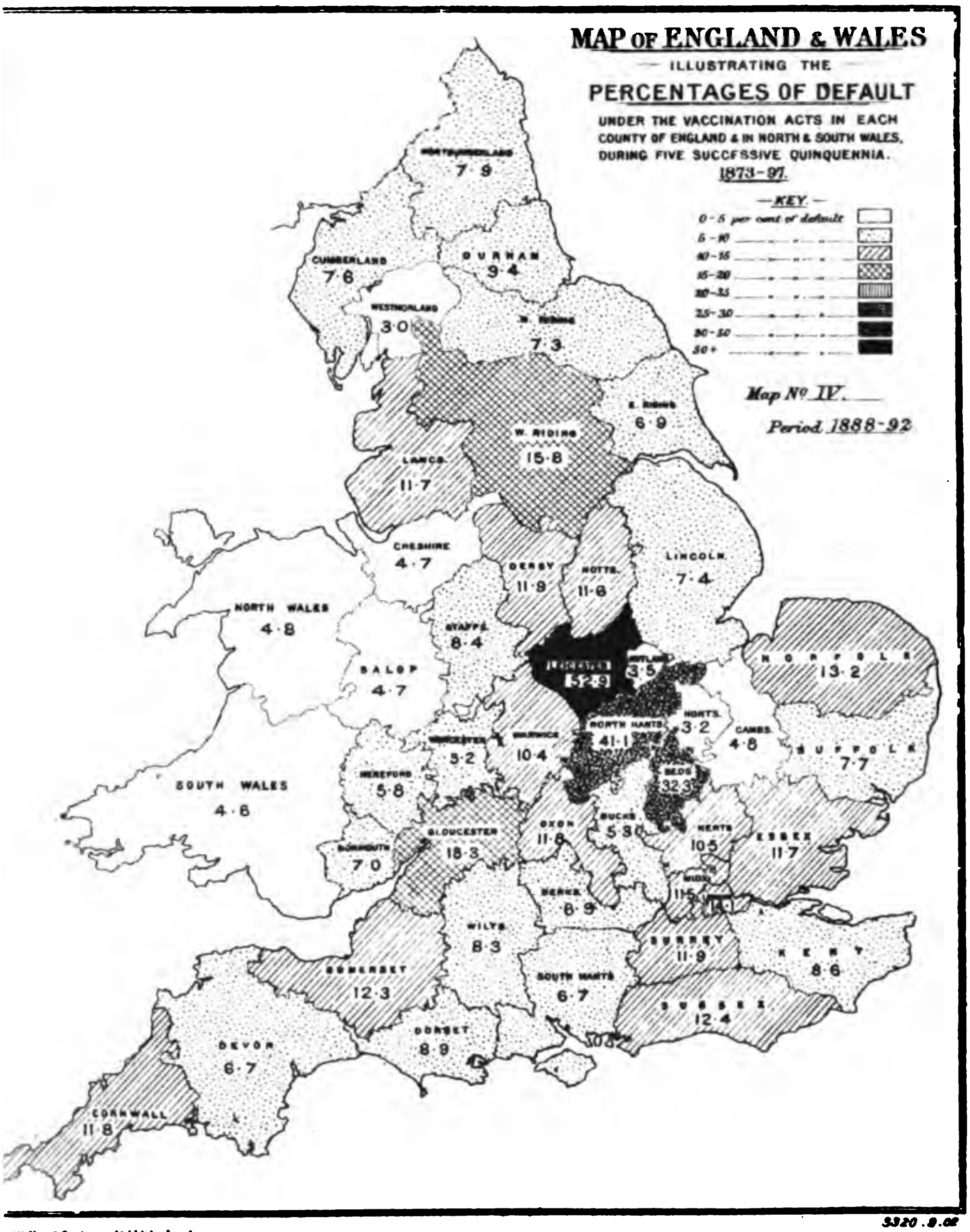

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MAP IV.

Showing PERCENTAGES on REGISTERED BIRTHS of DEFAULT under the VACCINATION ACTS in respect of the Period 1888–92.

COUNTIES in ORDER of DEFAULT.

Division I.	Division II.	Division III.	Division IV.
0–5 per cent.	5–10 per cent.	10–15 per cent.	15–20 per cent.
1. Westmorland. 3·0	9. Worcester 5·2	27. Warwick 10·4	41. W. Riding 15·6
2. Hunts .. 3·2	10. Bucks .. 5·3	28. Herts .. 10·5	42. Gloucester 18·3
3. Rutland .. 3·5	11. Hereford .. 5·8	29. Middlesex 11·5	(2 Counties.)
4. S. Wales .. 4·6	12. { Devon .. 6·7	30. Notts .. 11·6	
5. { Chester .. 4·7	S. Hants .. 6·7 }	31. { Essex .. 11·7	
Salop .. 4·7 }	14. { Berks .. 6·9	Lancs .. 11·7 }	
7. { Cambridge 4·8	E. Riding .. 6·9 }	33. { Cornwall 11·8	
N. Wales .. 4·8 }	16. Monmouth 7·0	Oxon .. 11·8 }	
(8 Counties.)	17. N. Riding . 7·3	35. { Derby .. 11·9	
	18. Lincs .. 7·4	Surrey .. 11·9 }	
	19. Cumberland 7·6	37. Somerset 12·3	
	20. Suffolk .. 7·7	38. Sussex .. 12·4	
	21. Northumberland. 7·9	39. Norfolk .. 13·2	
	22. Wilts .. 8·3	40. London .. 14·1	
	23. Staffs .. 8·4	(14 Counties.)	
	24. Kent .. 8·6		
	25. Dorset .. 8·9		
	26. Durham .. 9·4		
	(18 Counties.)		

Division V.	Division VI.	Division VII.	Division VIII.
20–25 per cent.	25–30 per cent.	30–50 per cent.	50+ per cent.
Nil.	Nil.	43. Bedford .. 33·3	45. Leicester 52·9
		44. N. Hants.. 41·1	(1 County.)
		(2 Counties.)	

Despite the growing opposition on the part of Boards of Guardians to the due administration of the Vaccination Acts, the counties yielding upwards of 30 per cent. of default had less than 3 per cent. of the total births registered in the country in 1892, the last year of the quinquennium. Instances of long drops in regard of numerical position in 1873–77 are to be found in the cases of Herts, Essex, Cornwall, Derby, Norfolk, and Bedford. Several counties have also greatly bettered their position, *e.g.*, S. Wales, Worcester, Hereford, S. Hants, E. Riding, N. Riding, and Lincs.

MAP V.

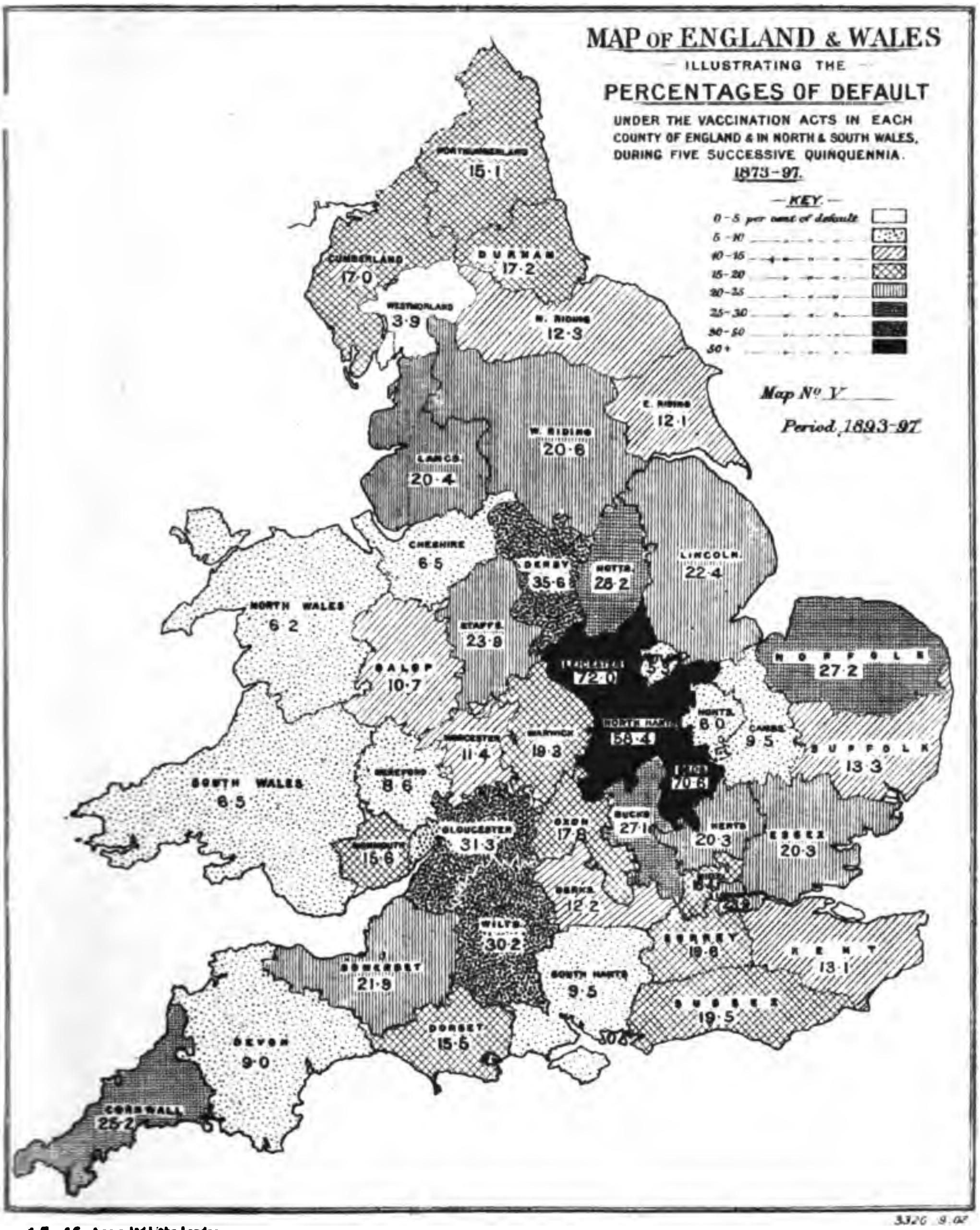
Showing PERCENTAGES on REGISTERED BIRTHS of DEFAULT under the VACCINATION ACTS in respect of the Period 1893–97.

COUNTIES in ORDER of DEFAULT.

Division I.	Division II.	Division III.	Division IV.
0–5 per cent.	5–10 per cent.	10–15 per cent.	15–20 per cent.
1. Westmorland. 3·9	2. Rutland .. 5·3	11. Salop .. 10·7	18. Northumberland. 15·1
(1 *County.*)	3. Hunts .. 6·0	12. Worcester 11·4	19. Dorset .. 15·5
	4. N. Wales .. 6·2	13. E. Riding 12·1	20. Monmouth 15·6
	5. { Chester .. 6·5	14. Berks .. 12·2	21. Cumberland. 17·0
	S. Wales .. 6·5 }	15. N. Riding 12·3	22. Durham 17·2
	7. Hereford .. 8·6	16. Kent .. 13·1	23. Oxon .. 17·8
	8. Devon .. 9·0	17. Suffolk .. 13·3	24. Middlesex 18·4
	9. { Cambridge .. 9·5	(7 *Counties.*)	25. Warwick 19·3
	S. Hants .. 9·5 }		26. Sussex .. 19·5
	(9 *Counties.*)		27. Surrey .. 19·6
			(10 *Counties.*)

Division V.	Division VI.	Division VII.	Division VIII.
20–25 per cent.	25–30 per cent.	30–50 per cent.	50+ per cent.
28. { Essex .. 20·3	36. Cornwall 25·2	40. Wilts .. 30·2	43. N. Hants 58·4
Herts .. 20·3 }	37. Bucks .. 27·1	41. Gloucester 31·3	44. Bedford .. 70·6
30. Lancs. .. 20·4	38. Norfolk .. 27·2	42. Derby ... 35·6	45. Leicester 72·0
31. W. Riding .. 20·6	39. Notts .. 28·2	(3 *Counties.*)	(3 *Counties.*)
32. Somerset .. 21·9	(4 *Counties.*)		
33. Lincs .. 22·4			
34. { London .. 23·9			
Staffs .. 23·9 }			
(8 *Counties.*)			

The births registered in the year 1897 in the counties figuring here in Divisions VI. to VIII. were only 12·3 per cent. of the total for the country.



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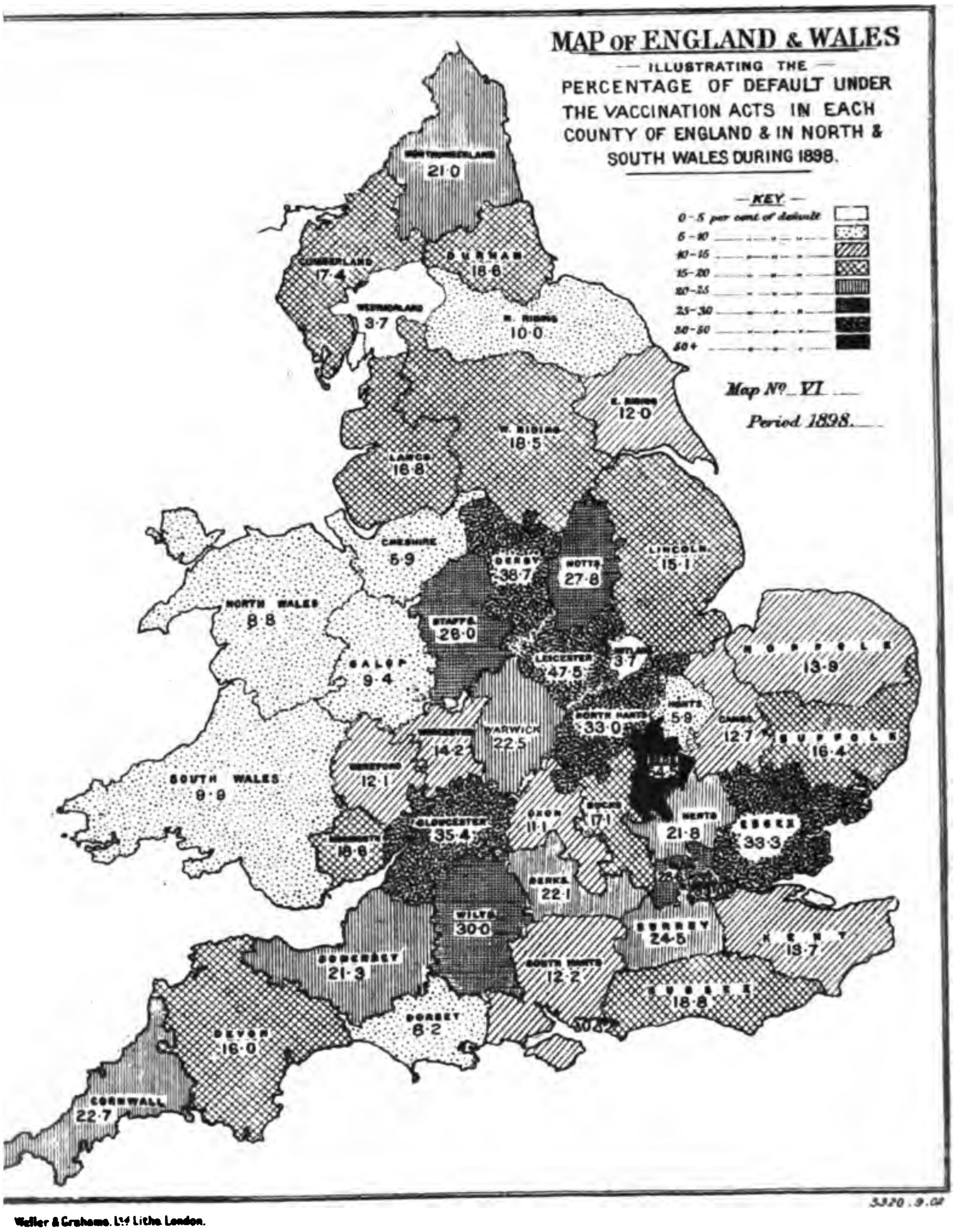

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MAP VI.

Showing PERCENTAGES on REGISTERED BIRTHS of DEFAULT under the VACCINATION ACTS in respect of the Year 1898.

COUNTIES in ORDER of DEFAULT.

Division I.	Division II.	Division III.	Division IV.
0-5 per cent.	5-10 per cent.	10-15 per cent.	15-20 per cent.
1. { Rutland .. 3·7	3. { Chester .. 5·9	10. Oxon .. 11·1	18. Lincoln .. 15·1
1. { Westmorland. 3·7	3. { Hunts .. 5·9	11. E. Riding 12·0	19. Devon .. 16·0
(2 *Counties.*)	5. Dorset .. 8·2	12. Hereford 12·1	20. Suffolk .. 16·4
	6. N. Wales .. 8·8	13. S. Hants .. 12·2	21. Lancs .. 16·8
	7. Salop .. 9·4	14. Cambridge 12·7	22. Bucks .. 17·1
	8. S. Wales .. 9·9	15. Kent .. 13·7	23. Cumberland. 17·4
	9. N. Riding .. 10·0	16. Norfolk .. 13·9	24. W. Riding 18·5
	(7 *Counties.*)	17. Worcester 14·2	25. { Durham 18·6
		(8 *Counties.*)	25. { Monmouth 18·6
			27. Sussex .. 18·8
			(10 *Counties.*)

Division V.	Division VI.	Division VII.	Division VIII.
20-25 per cent.	25-30 per cent.	30-50 per cent.	50 + per cent.
28. Northumberland. 21·0	35. Staffs .. 26·0	39. { London .. 33·0	45. Bedford. 54·5
29. Somerset 21·3	36. Notts .. 27·8	39. { N. Hants .. 33·0	(1 *County.*)
30. Herts .. 21·8	37. Middlesex 28·6	41. Essex .. 33·3	
31. Berks .. 22·1	38. Wilts .. 30·0	42. Gloucester 35·4	
32. Warwick 22·5	(4 *Counties.*)	43. Derby .. 38·7	
33. Cornwall 22·7		44. Leicester .. 47·5	
34. Surrey .. 24·5		(6 *Counties.*)	
(7 *Counties.*)			

Of the ten counties here figuring in Division IV. with less than 20 per cent. of "default," and the seven in Division V. with less than 25 per cent. of "default," eight (of the seventeen) are found to have upwards of 25 per cent. of "abstention from vaccination" in Map VII.

MAP VII.

Showing PERCENTAGES on REGISTERED BIRTHS of "ABSTENTION" from VACCINATION under the VACCINATION ACTS in respect of the year 1898.

[Children exempted from Vaccination under Section 2 of the Act of 1898 have here been added to the totals of Unvaccinated children figuring in the percentages of Map VI.]

COUNTIES in ORDER of ABSTENTION during the year, with the ORDER and PERCENTAGES of Map VI. also stated.

Division I. 0-5 per cent.

Order. Map VI.	Order. Map VII.	County.	Percentage. Map VI.	Percentage. Map VII.
		Nil.		

Division II. 5-10 per cent.

Order. Map VI.	Order. Map VII.	County.	Percentage. Map VI.	Percentage. Map VII.
1	1	Westmorland.	3·7	6·4
1	2	Rutland ..	3·7	7·0
3	3	Cheshire ..	5·9	7·4
3	4	Hunts ..	5·9	8·9
6	5	N. Wales ..	8·8	9·1
		(5 *Counties.*)		

Division III. 10-15 per cent.

Order. Map VI.	Order. Map VII.	County.	Percentage. Map VI.	Percentage. Map VII.
8	6	S. Wales ..	9·9	10·5
7	7	Salop ..	9·4	10·8
12	8	Hereford ..	12·1	14·4
13	9	S. Hants ..	12·2	14·9
		(4 *Counties.*)		

Division IV. 15-20 per cent.

Order. Map VI.	Order. Map VII.	County.	Percentage. Map VI.	Percentage. Map VII.
14	10	Cambridge	12·7	15·1
9	11	N. Riding	10·0	16·4
17	12	Worcester	14·2	16·5
11	13	E. Riding	12·0	16·7
15	14	Kent ..	13·7	17·4
19	14	Devon ..	16·0	17·4
		(6 *Counties.*)		

Division V. 20-25 per cent.

Order. Map VI.	Order. Map VII.	County.	Percentage. Map VI.	Percentage. Map VII.
25	16	Durham ..	18·6	21·4
20	17	Suffolk ..	16·4	21·6
23	18	Cumberland.	17·4	21·8
5	19	Dorset ..	8·2	22·1
25	20	Monmouth	18·6	22·3
10	21	Oxon ..	11·1	22·4
28	22	Northumberland.	21·0	23·2
24	23	W. Riding	18·5	23·5
21	24	Lancs ..	16·8	23·7
33	25	Cornwall ..	22·7	24·1
32	26	Warwick ..	22·5	24·6
31	27	Berks ..	22·1	24·8
		(12 *Counties.*)		

Division VI. 25-30 per cent.

Order. Map VI.	Order. Map VII.	County.	Percentage. Map VI.	Percentage. Map VII.
27	28	Sussex ..	18·8	25·1
34	29	Surrey ..	24·5	27·2
30	30	Herts	21·8	27·7
29	31	Somerset ..	21·3	28·0
35	32	Staffs ..	26·0	29·1
37	33	Middlesex	28·6	30·0
		(6 *Counties.*)		

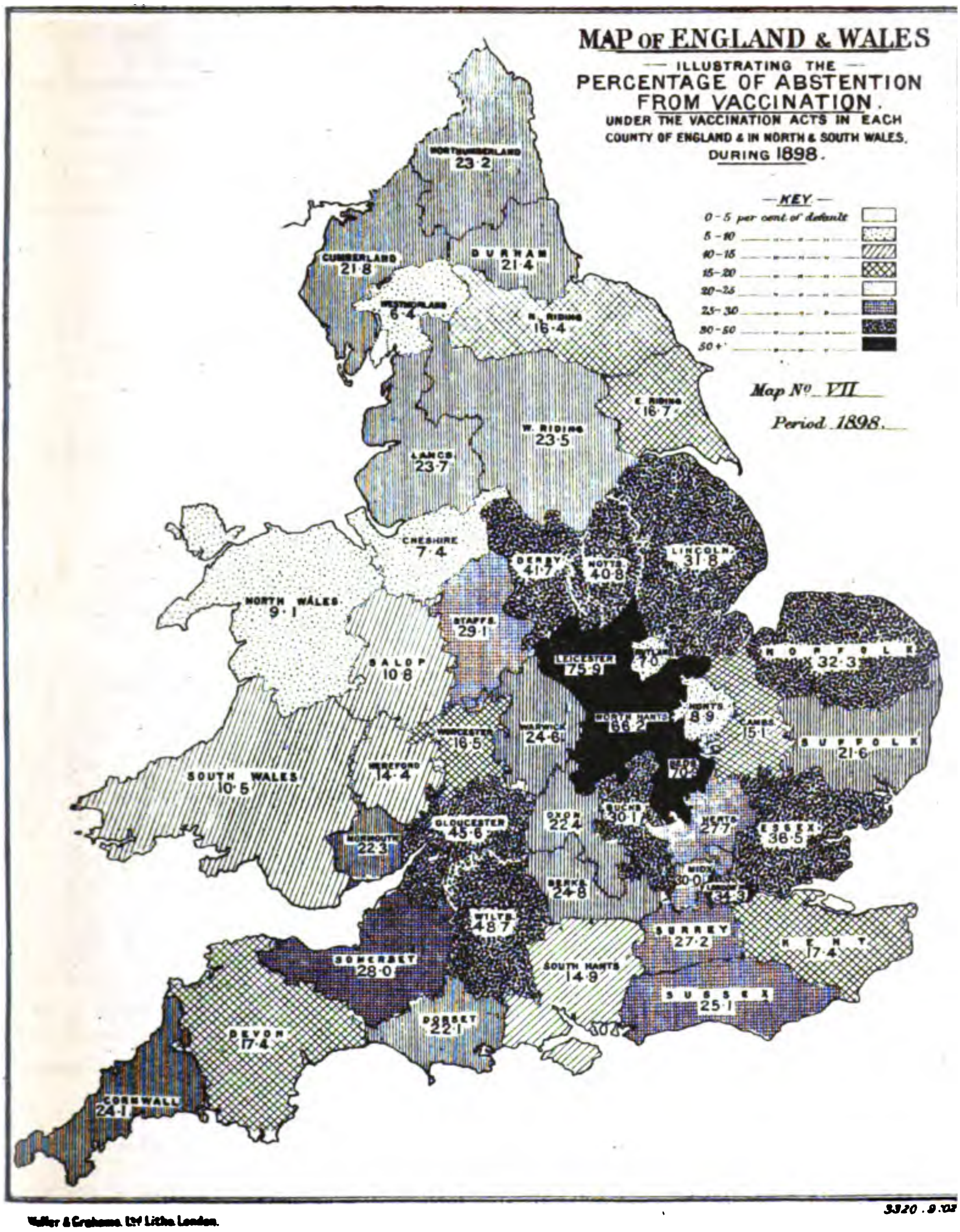
Division VII 30-50 per cent.

Order. Map VI.	Order. Map VII.	County.	Percentage. Map VI.	Percentage. Map VII.
22	34	Bucks ..	17·1	30·1
18	35	Lincs ..	15·1	31·8
16	36	Norfolk ..	13·9	32·3
39	37	London ..	33·0	34·3
41	38	Essex ..	33·3	36·5
36	39	Notts ..	27·8	40·8
43	40	Derby ..	38·7	41·7
42	41	Gloucester	35·4	45·6
38	42	Wilts ..	30·0	48·7
		(9 *Counties.*)		

Division VIII. 50 + per cent.

Order. Map VI.	Order. Map VII.	County.	Percentage. Map VI.	Percentage. Map VII.
39	43	N. Hants ..	33·0	66·2
45	44	Bedford ..	54·5	70·9
44	45	Leicester ..	47·5	75·9
		(3 *Counties.*)		

The eighteen counties having upwards of 25 per cent. of "abstention from vaccination" had among them 41·5 per cent. of the births registered in the country in 1898.



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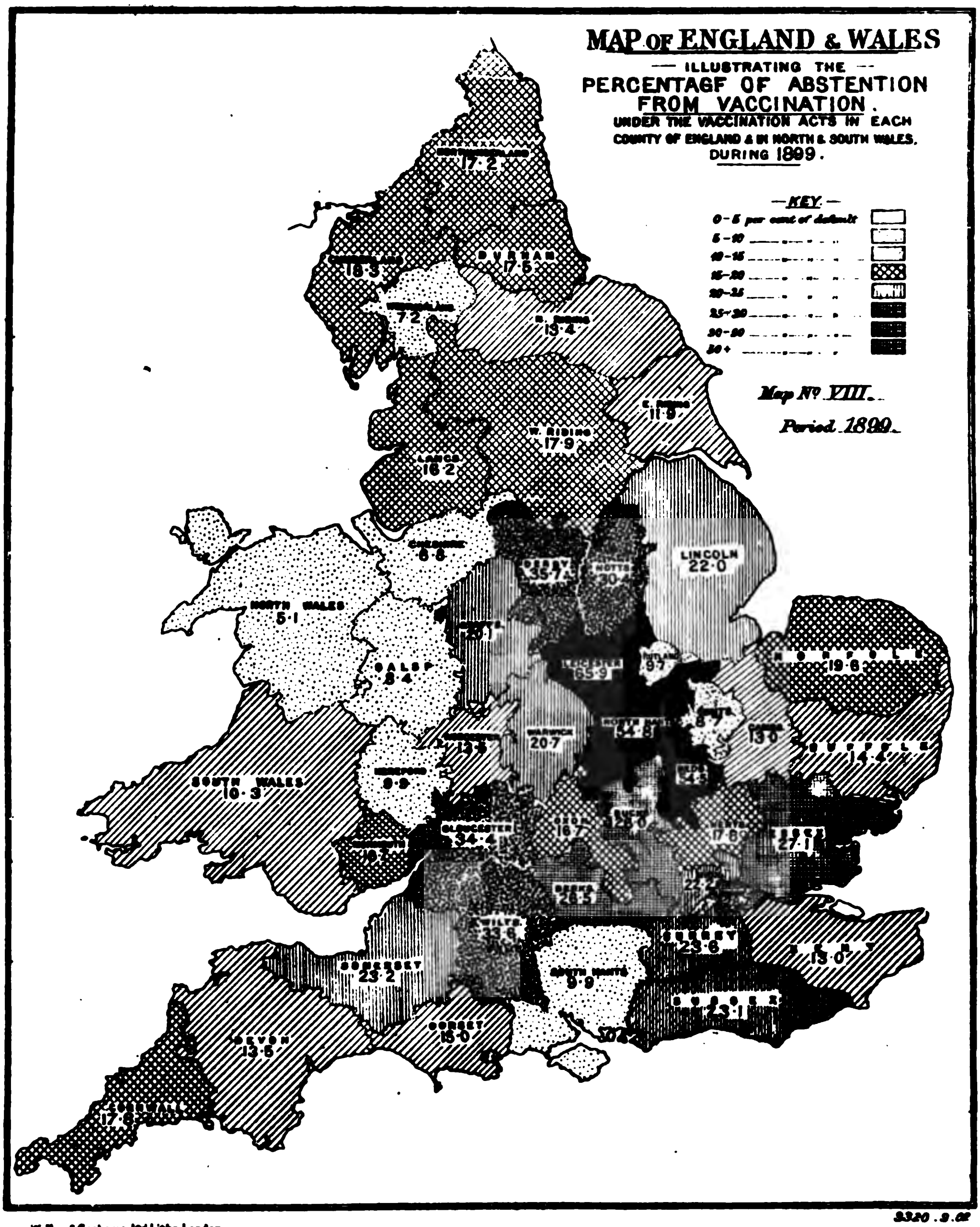

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MAP VIII.

Showing PERCENTAGES on REGISTERED BIRTHS of "ABSTENTION" from VACCINATION under the VACCINATION ACTS in respect of the Year 1899.

COUNTIES in ORDER of ABSTENTION.

Division I.	Division II.	Division III.	Division IV.
0–5 per cent.	5–10 per cent.	10–15 per cent.	15–20 per cent.
Nil.	1. N. Wales .. 5·1	9. S. Wales.. 10·3	19. Lancs .. 16·2
	2. Rutland .. 6·7	10. E. Riding 11·9	20. { Monmouth 16·7
	3. Cheshire .. 6·8	11. { Cambridge 13·0	{ Oxon .. 16·7
	4. Westmorland. 7·2	{ Kent .. 13·0	22. Northumberland. 17·2
	5. Salop .. 8·4	13. N. Riding 13·4	23. Durham 17·5
	6. Hunts .. 8·7	14. { Devon .. 13·5	24. Herts .. 17·8
	7. { Hereford .. 9·9	{ Worcester 13·5	25. W. Riding 17·9
	{ S. Hants .. 9·9	16. Suffolk .. 14·4	26. Cumberland. 18·3
	(8 *Counties.*)	17. Dorset .. 15·0	27. Norfolk.. 19·6
		18. Cornwall 17·8	(9 *Counties.*)
		(10 *Counties.*)	

Division V.	Division VI.	Division VII.	Division VIII.
20–25 per cent.	25–30 per cent.	30–50 per cent.	50 + per cent.
28. Staffs .. 20·1	35. Bucks .. 26·0	39. Notts .. 30·4	43. Bedford 54·5
29. Warwick 20·7	36. Berks .. 26·5	40. Wilts .. 33·6	44. N. Hants 54·8
30. Lincs .. 22·0	37. Essex .. 27·1	41. Gloucester 34·4	45. Leicester 65·9
31. Middlesex 22·2	38. London .. 28·7	42. Derby .. 35·7	(3 *Counties.*)
32. Sussex .. 23·1	(4 *Counties.*)	(4 *Counties.*)	
33. Somerset 23·2			
34. Surrey .. 23·6			
(7 *Counties.*)			

As showing what was relatively the small proportion of children involved in the larger amounts of "abstention" in respect of this year, it may be stated that the births registered in 1899 in the eleven counties in Divisions VI. to VIII. were only 27·9 per cent. of the total for the country generally. Moreover, ten of the eleven counties showed smaller percentages of abstention than as regards 1898.

MAP IX.

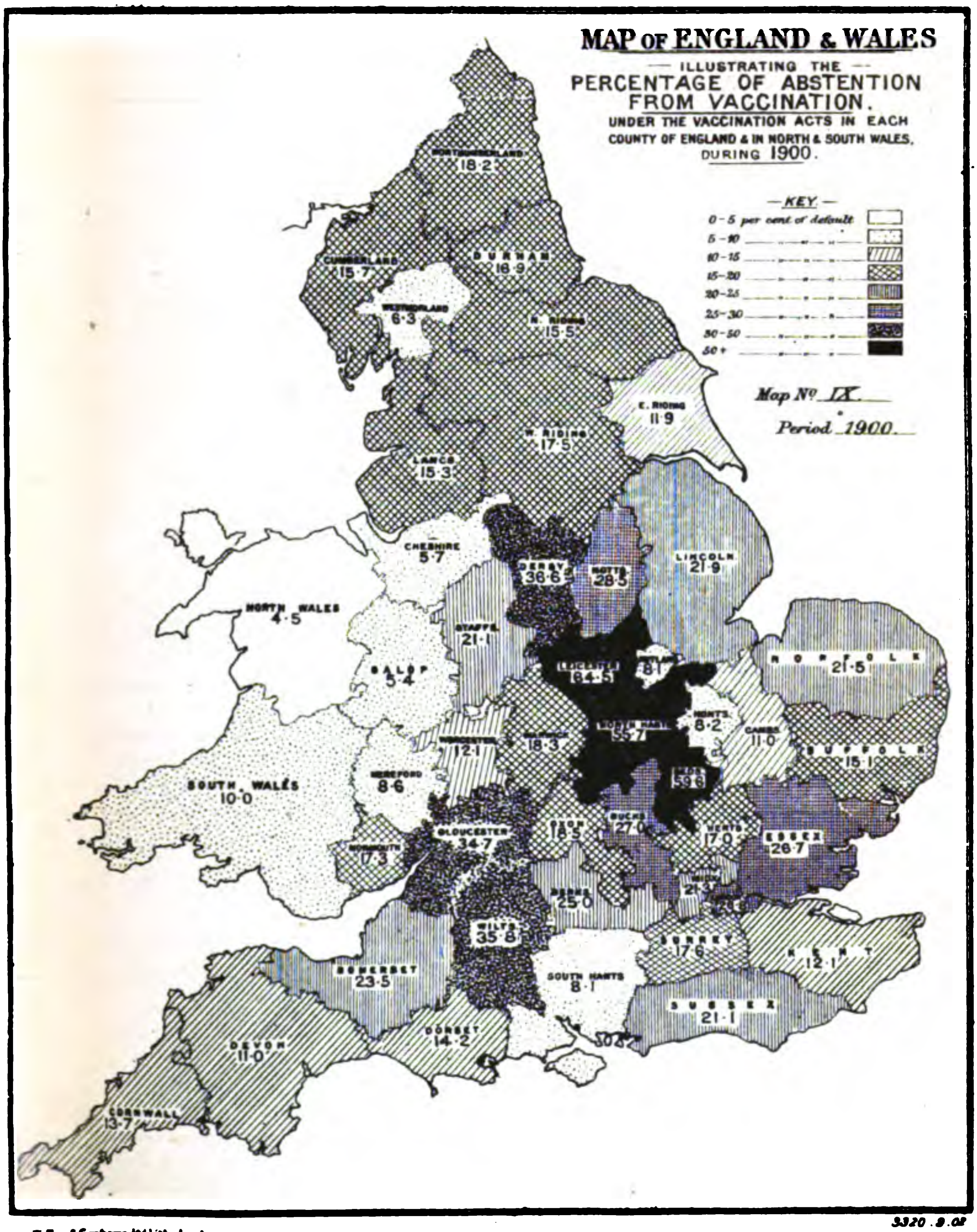
Showing PERCENTAGES on REGISTERED BIRTHS of "ABSTENTION" from VACCINATION under the VACCINATION ACTS in respect of the Year 1900.

COUNTIES in ORDER of ABSTENTION.

Division I.	Division II.	Division III.	Division IV.
0-5 per cent.	5-10 per cent.	10-15 per cent.	15-20 per cent.
1. N. Wales .. 4·5	2. Salop .. 5·4	10. Cambridge 11·0	17. Suffolk .. 15·1
(1 *County.*)	3. Cheshire .. 5·7	10. Devon .. 11·0	18. Lancs .. 15·3
	4. Westmorland. 6·3	12. E. Riding 11·9	19. N. Riding 15·5
	5. Rutland .. 8·1	13. Kent .. 12·1	20. Cumberland. 15·7
	5. S. Hants .. 8·1	13. Worcester 12·1	21. Durham 16·9
	7. Hunts .. 8·2	15. Cornwall 13·7	22. Herts .. 17·0
	8. Hereford .. 8·6	16. Dorset .. 14·2	23. Monmouth 17·3
	9. S. Wales .. 10·0	(7 *Counties.*)	24. W. Riding 17·5
	(8 *Counties.*)		25. Surrey .. 17·6
			26. Northumberland. 18·2
			27. Warwick 18·3
			28. Oxon .. 18·5
			(12 *Counties.*)

Division V.	Division VI.	Division VII.	Division VIII.
20-25 per cent.	25-30 per cent.	30-50 per cent.	50 + per cent.
29. Staffs .. 21·1	36. Essex .. 26·7	40. Gloucester 34·7	43. N. Hants 55·7
29. Sussex .. 21·1	37. London .. 26·8	41. Wilts .. 35·8	44. Bedford 59·6
31. Middlesex 21·3	38. Bucks .. 27·0	42. Derby .. 36·6	45. Leicester 64·5
32. Norfolk .. 21·5	39. Notts .. 28·5	(3 *Counties.*)	(3 *Counties.*)
33. Lincs .. 21·9	(4 *Counties.*)		
34. Somerset 23·5			
35. Berks .. 25·0			
(7 *Counties.*)			

The ten counties here showing "abstention" from vaccination of upwards of 25 per cent. of births yielded births equal to only 27 per cent. of the total of births registered during 1900 in the country generally. Moreover, four of the ten counties showed percentages lower than in 1898 or 1899, and the remaining six counties had percentages lower than in 1898.



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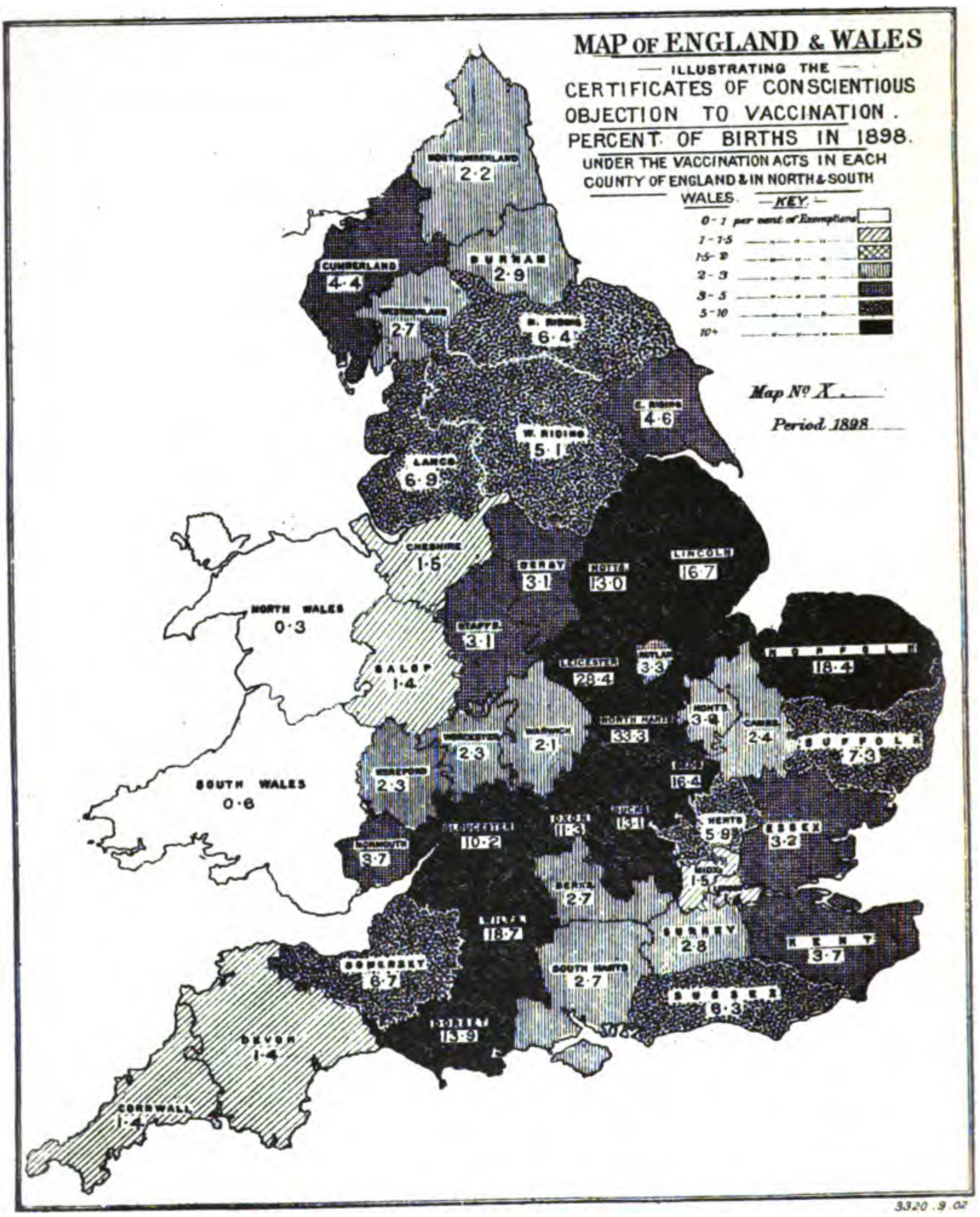

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MAP X.

Showing the Percentages on Registered Births of Children Exempted from Vaccination under Section 2 of the Act of 1898 in respect of the Year 1898.

Counties in Order of Percentages.

Division I.	Division II.	Division III.	Division IV.
0-1 per cent.	1-1·5 per cent.	1·5-2 per cent.	2-3 per cent.
1. N. Wales .. 0·3	3. Cornwall .. 1·4	Nil.	9. Warwick 2·1
2. S. Wales .. 0·6	3. Devon .. 1·4		10. Northumberland. 2·2
(2 *Counties.*)	3. London .. 1·4		11. Hereford 2·3
	3. Salop .. 1·4		11. Worcester 2·3
	7. Cheshire .. 1·5		13. Cambridge 2·4
	7. Middlesex .. 1·5		14. Berks .. 2·7
	(6 *Counties.*)		14. S. Hants .. 2·7
			14. Westmorland. 2·7
			17. Surrey .. 2·8
			18. Durham .. 2·9
			19. Hunts .. 3·0
			(11 *Counties.*)

Division V.	Division VI.	Division VII.
3-5 per cent.	5-10 per cent.	10 + per cent.
20. Derby .. .. 3·1	28. W. Riding .. .. 5·1	35. Gloucester.. .. 10·2
20. Staffs .. .. .. 3·1	29. Herts .. .. .. 5·9	36. Oxon .. .. 11·3
22. Essex .. .. .. 3·2	30. Sussex .. .. 6·3	37. Notts .. .. 13·0
23. Rutland .. .. 3·3	31. N. Riding .. .. 6·4	38. Bucks .. .. 13·1
24. Kent .. .. .. 3·7	32. Somerset .. .. 6·7	39. Dorset .. .. 13·9
24. Monmouth .. .. 3·7	33. Lancs .. .. 6·9	40. Bedford .. .. 16·4
26. Cumberland .. 4·4	34. Suffolk .. .. 7·3	41. Lincs .. .. 16·7
27. E. Riding .. .. 4·6	(7 *Counties.*)	42. Norfolk .. .. 18·4
(8 *Counties.*)		43. Wilts .. .. 18·7
		44. Leicester .. .. 28·4
		45. N. Hants .. .. 33·3
		(11 *Counties.*)

The average rate of exemptions for the country was 5·1 per cent. of registered births. The seventeen counties having ratios above this average yielded only 31·9 per cent. of births registered in the country generally.

MAP XI.

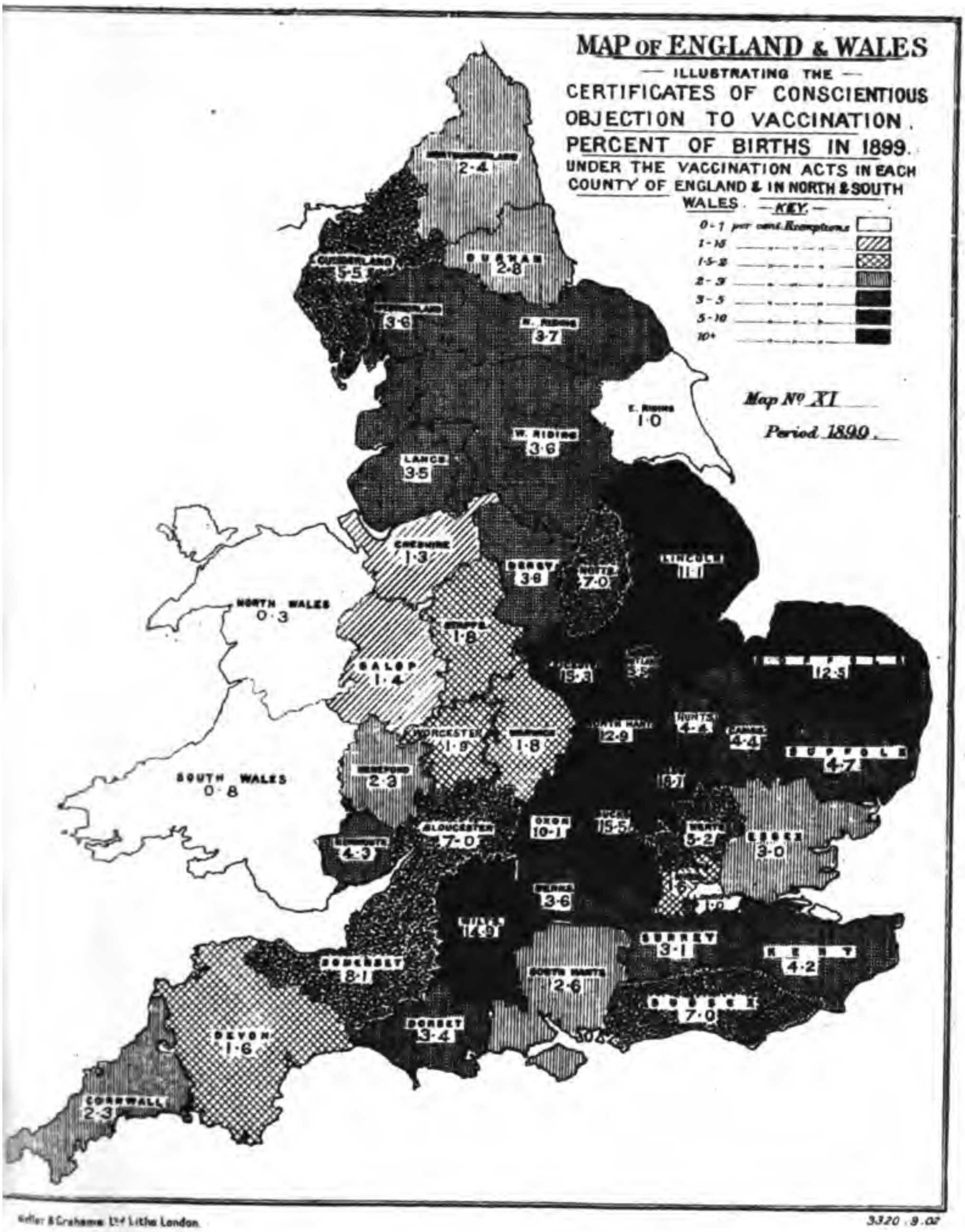
Showing the PERCENTAGES on REGISTERED BIRTHS of CHILDREN EXEMPTED from VACCINATION under Section 2 of the Act of 1898 in respect of the Year 1899.

COUNTIES in ORDER of PERCENTAGES.

Division I.	Division II.	Division III.	Division IV.
0-1 per cent.	1-1·5 per cent.	1·5-2 per cent.	2-3 per cent.
1. N. Wales .. 0·3	5. Cheshire .. 1·3	7. { Devon .. 1·6	12. { Cornwall 2·3
2. S. Wales .. 0·8	6. Salop .. 1·4	Middlesex 1·6	Hereford 2·3
3 { E. Riding .. 1·0	(2 *Counties.*)	9. { Staffs .. 1·8	14. Northumberland. 2·4
London .. 1·0		Warwick .. 1·8	15. S. Hants .. 2·6
(4 *Counties.*)		11. Worcester 1·9	16. Durham 2·8
		(5 *Counties.*)	17. Essex .. 3·0
			(6 *Counties.*)

Division V.	Division VI.	Division VII.
3-5 per cent.	5-10 per cent.	10 + per cent.
18. Surrey .. .. 3·1	31. Herts .. .. .. 5·2	38. Oxon .. .. 10·1
19. Dorset .. .. 3·4	32. { Cumberland .. 5·5	39. Lincs .. .. 11·1
20. Lancs .. .. 3·5	Rutland .. .. 5·5	40. Norfolk .. .. 12·5
21. { Berks .. .. 3·6	34. { Gloucester .. .. 7·0	41. N. Hants .. .. 12·9
Derby .. .. 3·6	Notts .. .. .. 7·0	42. Wilts .. .. 14·9
Westmorland .. 3·6	Sussex .. .. 7·0	43. Leicester .. .. 15·3
W. Riding .. .. 3·6	37. Somerset .. .. 8·1	44. Bucks .. .. 15·5
25. N. Riding .. .. 3·7	(7 *Counties.*)	45. Beds .. .. .. 18·1
26. Kent .. .. .. 4·2		(8 *Counties.*)
27. Monmouth .. .. 4·3		
28. { Cambridge .. .. 4·4		
Hunts .. .. .. 4·4		
30. Suffolk .. .. 4·7		
(13 *Counties.*)		

The average rate of exemptions for the country was 3·6 per cent. of registered births. The twenty one counties having rates in excess of the average yielded only 21·8 per cent. of births registered in the country generally.



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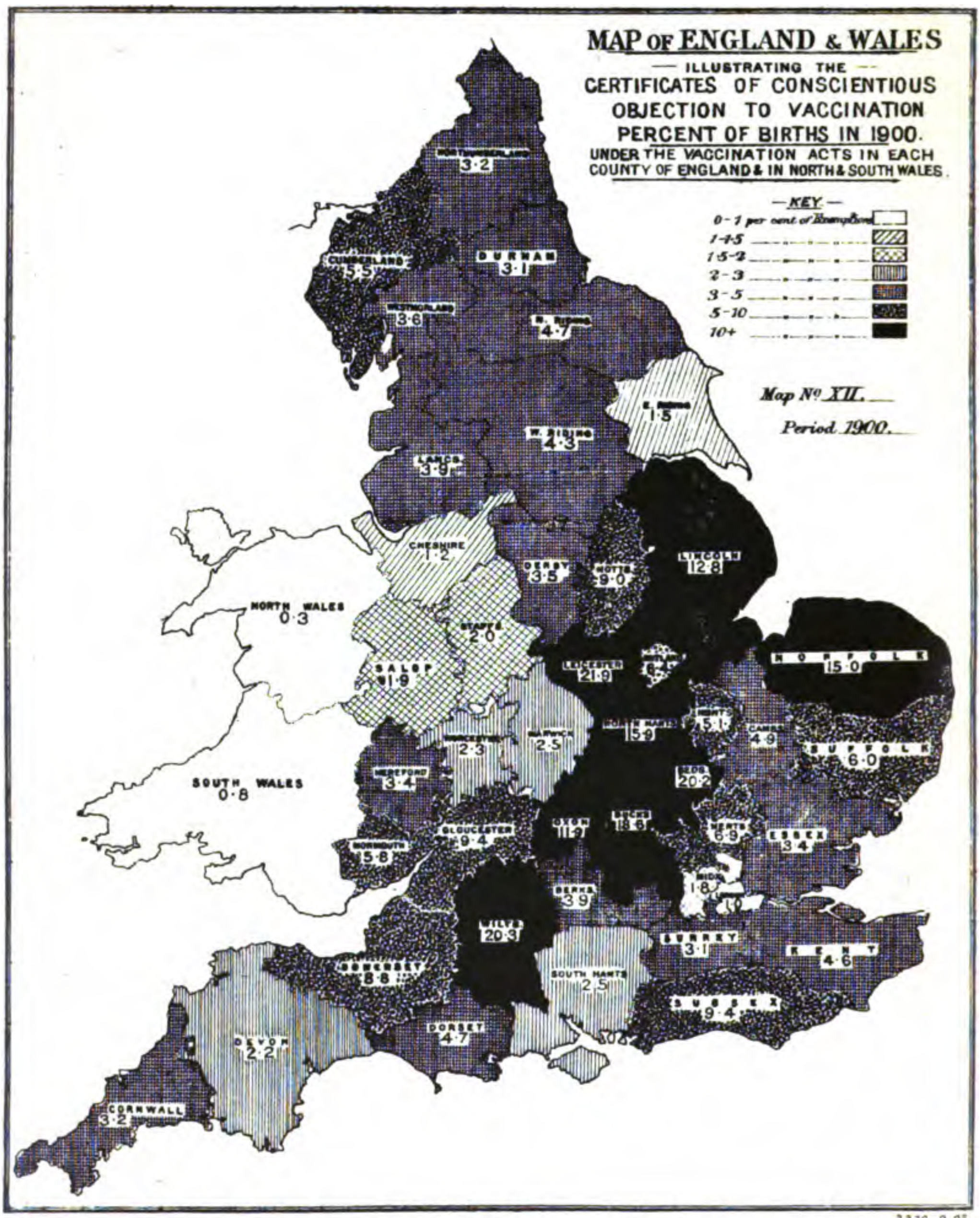

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MAP XII.

Showing the PERCENTAGES on REGISTERED BIRTHS of CHILDREN EXEMPTED from VACCINATION under Section 2 of the Act of 1898 in respect of the Year 1900.

COUNTIES in ORDER of PERCENTAGES.

Division I.	Division II.	Division III.	Division IV.
0-1 per cent.	1-1·5 per cent.	1·5-2 per cent.	2-3 per cent.
1. N. Wales .. 0·3	4. Cheshire .. 1·2	6. Middlesex .. 1·8	9. Devon .. 2·2
2. S. Wales .. 0·8	5. E. Riding .. 1·5	7. Salop .. 1·9	10. Worcester 2·3
3. London .. 1·0	(2 *Counties.*)	8. Staffs .. 2·0	11. { S. Hants .. 2·5
(3 *Counties.*)		(3 *Counties.*)	11. { Warwick 2·5
			(4 *Counties.*)

Division V.	Division VI.	Division VII.
3-5 per cent.	5-10 per cent.	10 + per cent.
13. { Durham .. .. 3·1	28. Hunts.. .. .. 5·1	38. Oxon .. .. 11·9
13. { Surrey .. .. 3·1	29. Cumberland .. 5·5	39. Lincs .. .. 12·8
15. { Cornwall .. .. 3·2	30. Monmouth .. .. 5·8	40. Norfolk .. .. 15·0
15. { Northumberland .. 3·2	31. Suffolk .. .. 6·0	41. N. Hants .. .. 15·9
17 { Essex .. .. .. 3·4	32. Rutland .. .. 6·4	42. Bucks .. .. 18·6
17 { Hereford .. .. 3·4	33. Herts .. .. .. 6·9	43. Bedford .. .. 20·2
19. Derby .. .. 3·5	34. Somerset .. .. 8·8	44. Wilts .. .. 20·3
20. Westmorland .. 3·6	35. Notts .. .. .. 9·0	45. Leicester .. .. 21·9
21. { Berks .. .. .. 3·9	36. { Gloucester .. .. 9·4	(8 *Counties.*)
21. { Lancs .. .. .. 3·9	36. { Sussex .. .. 9·4	
23. W. Riding .. .. 4·3	(10 *Counties.*)	
24. Kent .. .. .. 4·6		
25. { Dorset .. .. 4·7		
25. { N. Riding .. .. 4·7		
27. Cambridge .. .. 4·9		
(15 *Counties.*)		

The average rate of exemptions for the country was 4·3 per cent. of registered births. The twe[illegible]o counties having rates in excess of the average yielded only 17·6 per cent. of births registered in the country generally

No. 5.

APP. A, No. 5.

Inspection of Vaccination, and Awards to Public Vaccinators, 1901.

Inspection of Public Vaccination.

LIST (alphabetically arranged) of 235 UNIONS inspected during the Year 1901, with reference to the PROCEEDINGS under the VACCINATION ACTS, 1867 to 1898, and an ACCOUNT of the AWARDS certified by the Board as payable to the respective PUBLIC VACCINATORS out of COUNTY FUNDS.

UNION.	No. of Vaccination Districts in the Union.	No. of Public Vaccinators recommended for Award.	Range of Awards in each Union. Minimum.	Range of Awards in each Union. Maximum.	Total Sum awarded in each Union.	Medical Inspector.
			£ s. d.	£ s. d.	£ s. d.	
Alnwick	7	6	1 11 0	8 8 0	22 5 0	Dr. Johnstone.
Alston-with-Garrigill	2	—	—	—	—	„ Manby.
Amersham	6	3	4 6 0	12 9 0	21 11 0	„ Fletcher.
Amesbury	2	1	—	—	5 9 0	„ Mivart.
Ampthill	6	6	3 4 0	6 18 0	28 8 0	„ Fletcher.
Austell, St.	5	2	6 19 0	11 13 0	18 12 0	Mr. Boyle.
Axbridge	11	5	2 12 0	6 9 0	22 5 0	Do.
Aylesbury	8	7	1 7 0	16 3 0	34 13 0	Dr. Fletcher.
Aylsham	7	6	4 16 0	8 9 0	41 14 0	„ Copeman.
Bala	1	1	—	—	5 12 0	Dr. Wheaton.
Bangor and Beaumaris	6	4	6 7 0	9 7 0	30 3 0	Do.
Barnsley	9	3	4 0 0	39 6 0	57 14 0	„ Johnstone.
Barrow-in-Furness ..	1	—	—	—	—	„ Wheaton.
Basingstoke	8	6	0 9 0	12 11 0	24 17 0	„ Bulstrode.
Bath	5	5	3 5 0	28 6 0	54 11 0	Mr. Royle.
Battle	8	6	1 2 0	10 6 0	23 14 0	Dr. Thomson.
Beaminster	6	5	1 10 0	7 8 0	23 1 0	Mr. Royle.
Bedford	8	7	1 2 0	4 8 0	16 18 0	Dr. Fletcher.
Belford	2	2	3 13 0	9 13 0	13 6 0	„ Johnstone.
Bellingham	6	—	—	—	—	Do
Belper	9	5	9 8 0	12 12 0	55 11 0	Do.
Berwick-on-Tweed ..	3	2	1 8 0	9 6 0	10 14 0	Do.
Biggleswade	6	5	2 12 0	10 15 0	38 18 0	„ Fletcher.
Birkenhead	3	3	13 10 0	109 14 0	144 7 0	„ Wheaton.

UNION.	No. of Vaccination Districts in the Union.	No. of Public Vaccinators recommended for Award.	Range of Awards in each Union. Minimum.	Range of Awards in each Union. Maximum.	Total Sum awarded in each Union.	Medical Inspector.
			£ s. d.	£ s. d.	£ s. d.	
Birmingham (L.A.) ..	1	1	—	—	153 11 0	Dr. Sweeting.
Blackburn . ..	10	6	0 10 0	39 18 0	117 5 0	" Wheaton.
Blandford	5	5	0 13 0	7 15 0	19 15 0	Mr. Royle.
Blean	4	3	8 16 0	13 2 0	31 5 0	Dr. Reece.
Bodmin..	8	6	1 14 0	5 0 0	20 13 0	Mr. Royle.
Bootle	3	3	3 3 0	17 3 0	25 15 0	Dr. Manby.
Boston	7	5	2 8 0	27 8 0	60 1 0	" Copeman.
Brackley	4	1	—	—	8 3 0	" Darra Mair.
Bradford-on-Avon ..	3	1	—	—	2 14 0	" Mivart.
Brampton	1	1	—	—	11 2 0	" Manby.
Brecknock	3	3	8 14 0	18 2 0	39 4 0	" Mivart.
Bridgend and Cowbridge.	8	8	4 0 0	35 16 0	142 16 0	Do.
Bridgwater	10	4	1 9 0	4 3 0	12 8 0	Mr. Royle.
Bridgnorth	3	2	2 15 0	8 13 0	11 8 0	Dr. Reece.
Bridport	3	3	3 18 0	17 3 0	28 11 0	Mr. Royle.
Brighton	2	2	17 19 0	19 2 0	37 1 0	Dr. Thomson.
Bristol	8	8	5 18 0	36 14 0	101 10 0	" Sweeting.
Brixworth	5	5	0 16 0	3 12 0	12 0 0	" Darra Mair.
Buckingham	3	2	5 4 0	7 4 0	12 8 0	" Fletcher.
Bucklow	6	5	4 5 0	28 13 0	61 8 0	" Wheaton.
Builth	1	1	—	—	19 7 0	" Mivart.
Burton-on-Trent ..	7	7	3 0 0	51 15 0	115 15 0	" Reece.
Calne	1	1	—	—	9 12 0	Dr. Mivart.
Camelford	2	—	—	—	—	Mr. Royle.
Cannock	10	6	1 1 0	7 5 0	22 11 0	Dr. Reece.
Carlisle	5	4	3 10 0	66 14 0	80 19 0	" Manby.
Carmarthen	6	4	4 5 0	23 6 0	53 3 0	" Mivart.
Carnarvon	7	6	4 7 0	21 5 0	76 19 0	" Wheaton.
Castle Ward	7	2	18 16 0	26 13 0	45 9 0	" Johnstone.
Cerne	3	3	1 3 0	6 4 0	12 9 0	Mr. Royle.
Chard	8	7	1 10 0	11 7 0	36 19 0	Do.
Cheadle	5	2	7 7 0	18 3 0	25 10 0	Dr. Reece.
Chelsea	2	2	5 1 0	33 2 0	37 3 0	" Sweeting.
Chesterfield	16	9	4 6 0	26 16 0	154 5 0	" Johnstone.
Chester-le-Street ..	4	3	17 8 0	45 11 0	92 11 0	" Manby.

APP. A, No. 5.

Inspection of Vaccination, and Awards to Public Vaccinators, 1901.

UNION.	No. of Vaccination Districts in the Union.	No. of Public Vaccinators recommended for Award.	Range of Awards in each Union. Minimum.	Range of Awards in each Union. Maximum.	Total Sum awarded in each Union.	Medical Inspector.
			£ s. d.	£ s. d.	£ s. d.	
Chippenham	7	—	—	—	—	Dr. Mivart.
Christchurch	3	3	8 1 0	35 8 0	57 19 0	" Bulstrode.
Clutton	5	4	3 10 0	29 7 0	47 5 0	Mr. Royle.
Cockermouth	5	4	4 19 0	45 10 0	89 0 0	Dr. Manby.
Columb, St., Major ..	6	6	1 7 0	9 10 0	28 6 0	Mr. Royle.
Congleton	3	2	5 12 0	28 15 0	34 7 0	Dr. Wheaton.
Conway	3	1	—	—	13 17 0	Do.
Corwen	4	3	4 11 0	7 11 0	17 5 0	Do.
Crickhowell	2	1	—	—	9 15 0	" Mivart.
Cricklade and Wootton Bassett.	4	2	3 17 0	5 8 0	9 5 0	Do.
Depwade	8	5	2 3 0	9 18 0	30 14 0	Dr. Copeman.
Derby	2	2	13 7 0	26 0 0	39 7 0	" Johnstone.
Devizes	7	6	0 7 0	5 3 0	15 12 0	" Mivart.
Dewsbury	13	10	1 17 0	23 3 0	114 10 0	" Johnstone.
Docking	4	1	—	—	9 7 0	" Copeman.
Dolgelly	5	5	2 1 0	11 0 0	26 8 0	" Wheaton.
Dorchester	6	4	1 5 0	13 11 0	23 5 0	Mr. Royle.
Downham	7	4	2 14 0	15 9 0	35 11 0	Dr. Copeman.
Drayton	5	3	1 2 0	5 1 0	8 13 0	" Reece.
Dulverton	2	2	0 5 0	8 3 0	8 8 0	Mr. Royle.
Eastbourne	4	3	1 17 0	6 9 0	10 5 0	Dr. Thomson.
East Grinstead ..	5	5	1 9 0	4 0 0	13 16 0	Do.
East Ward	6	4	1 1 0	5 4 0	15 5 0	" Manby.
Edmonton	16	14	0 6 0	39 15 0	205 14 0	" Fletcher.
Erpingham	3	3	10 10 0	17 6 0	43 17 0	" Copeman.
Eton	9	7	0 12 0	12 4 0	45 14 0	" Fletcher.
Falmouth	4	2	5 0 0	9 7 0	14 7 0	Mr. Royle.
Festiniog	5	3	4 8 0	15 2 0	27 12 0	Dr. Wheaton.
Freebridge Lynn ..	5	3	1 16 0	25 3 0	34 7 0	" Copeman.
Frome	5	3	2 11 0	9 18 0	16 6 0	Mr. Royle.

UNION.	No. of Vaccination Districts in the Union.	No. of Public Vaccinators recommended for Award.	Range of Awards in each Union. Minimum.	Range of Awards in each Union. Maximum.	Total Sum awarded in each Union.	Medical Inspector.
			£ s. d.	£ s. d.	£ s. d.	
George, St., East	1	—	—	—	—	Dr. Sweeting.
Germans, St.	6	6	2 8 0	11 0 0	32 18 0	Mr. Royle.
Glendale	6	4	0 12 0	10 12 0	13 4 0	Dr. Johnstone.
Gloucester	2	2	15 5 0	32 18 0	48 3 0	„ Mivart.
Gower	3	1	—	—	5 1 0	Do.
Guiltcross	5	3	5 12 0	7 16 0	19 1 0	„ Copeman.
Hackney	5	5	8 15 0	69 9 0	201 2 0	Dr. Sweeting.
Hailsham	6	5	1 3 0	4 17 0	15 13 0	„ Thomson.
Haltwhistle	4	2	5 17 0	6 10 0	12 7 0	„ Johnstone.
Hardingstone	3	3	3 16 0	5 9 0	13 9 0	„ Darra Mair.
Havant	4	3	1 7 0	4 19 0	9 13 0	„ Bulstrode.
Hay	3	2	5 12 0	7 13 0	13 5 0	„ Mivart.
Headington	2	2	10 10 0	68 11 0	79 1 0	Mr. Royle.
Helston	6	2	6 7 0	7 15 0	14 2 0	Do.
Hemsworth	4	4	1 8 0	31 0 0	61 6 0	Dr. Johnstone.
Hendon	6	4	2 7 0	27 14 0	45 6 0	„ Fletcher.
Hexham	12	4	0 15 0	4 9 0	8 14 0	„ Johnstone.
Holbeach	6	5	2 8 0	9 7 0	29 3 0	„ Copeman.
Huddersfield	16	12	2 13 0	22 19 0	131 9 0	„ Johnstone.
Huntingdon	5	4	4 17 0	17 8 0	44 10 0	Mr. Royle.
Ives, St.	5	5	2 10 0	10 18 0	37 2 0	Mr. Royle.
Keighley	5	4	0 16 0	12 1 0	23 18 0	Dr. Johnstone.
Kendal	9	9	3 18 0	16 3 0	72 7 0	„ Manby.
Kettering	6	5	0 12 0	3 12 0	9 17 0	„ Darra Mair.
Keynsham	6	4	0 2 0	23 1 0	40 3 0	Mr. Royle.
King's Lynn	1	1	—	—	7 9 0	Dr. Copeman
Lancaster	5	3	4 17 0	49 17 0	75 1 0	Dr. Wheaton
Lanchester	4	2	26 14 0	58 5 0	84 19 0	„ Manby.
Langport	6	4	1 9 0	5 18 0	15 15 0	Mr. Royle.

APP. A, No. 5.

Inspection of Vaccination, and Awards to Public Vaccinators, 1901.

UNION.	No. of Vaccination Districts in the Union.	No. of Public Vaccinators recommended for Award.	Range of Awards in each Union. Minimum.	Range of Awards in each Union. Maximum.	Total Sum awarded in each Union.	Medical Inspector.
			£ s. d.	£ s. d.	£ s. d.	
Launceston	8	5	1 1 0	5 7 0	15 7 0	Mr. Royle.
Leek	6	5	1 5 0	24 17 0	57 1 0	Dr. Reece.
Leighton Buzzard ..	2	2	0 16 0	12 1 0	12 17 0	" Fletcher.
Lewisham	6	5	5 12 0	23 11 0	72 2 0	" Sweeting.
Lichfield	6	5	1 6 0	24 5 6	53 18 0	" Reece.
Liskeard	8	4	3 3 0	9 8 0	22 0 0	Mr. Royle.
Liverpool	3	3	42 19 0	93 7 0	196 15 0	Dr. Wheaton.
Llandilofawr	7	7	2 17 0	20 10 0	68 2 0	" Mivart.
Llandovery	3	—	—	—	—	Do.
Llanelly..	3	3	20 10 0	111 11 0	159 12 0	Do.
Loddon and Clavering	4	3	4 19 0	6 3 0	16 16 0	Dr. Copeman.
London City	2	2	8 0 0	12 2 0	20 2 0	" Sweeting.
Long Ashton	9	7	1 9 0	4 16 0	20 3 0	Mr. Royle.
Longtown	2	2	3 6 0	9 8 0	12 14 0	Dr. Manby.
Lunesdale	4	2	1 15 0	7 16 0	9 11 0	" Wheaton.
Luton	5	4	0 7 0	3 13 0	8 4 0	" Fletcher.
Macclesfield	6	6	4 3 0	54 12 0	89 14 0	Dr. Wheaton.
Madeley	4	4	4 10 0	28 16 0	52 19 0	" Reece.
Malmesbury	4	—	—	—	—	" Mivart.
Marlborough	2	2	3 7 0	9 18 0	13 5 0	Do.
Marylebone, St. ..	2	1	—	—	122 9 0	" Sweeting.
Mere	2	2	3 16 0	5 13 0	9 9 0	" Mivart.
Merthyr Tydfil ..	10	7	9 4 0	85 5 0	270 12 0	Do.
Mile End Old Town..	2	1	—	—	19 1 0	" Sweeting.
Mitford and Launditch.	8	3	1 3 0	13 10 0	27 2 0	" Copeman.
Morpeth	9	1	—	—	7 16 0	" Johnstone.
Nantwich	7	5	3 0 0	20 2 0	34 10 0	Dr. Wheaton.
Neath	6	6	14 7 0	70 6 0	211 10 0	" Mivart.
Neot's, St.	6	6	0 18 0	14 9 0	32 19 0	Mr. Royle.
Newcastle-in-Emlyn	3	3	8 6 0	16 13 0	39 15 0	Dr. Mivart.
Newcastle-under-Lyme.	3	1	—	—	48 12 0	" Reece.

UNION.	No. of Vaccination Districts in the Union.	No. of Public Vaccinators recommended for Award.	Range of Awards in each Union. Minimum.	Range of Awards in each Union. Maximum.	Total Sum awarded in each Union.	Medical Inspector.
			£ s. d.	£ s. d.	£ s. d.	
Newhaven	5	2	0 2 0	9 3 0	9 5 0	Dr. Thomson.
Newport (Salop) ..	4	2	5 6 0	8 7 0	13 13 0	" Reece.
Newport Pagnell ..	10	9	1 5 0	12 12 0	45 17 0	" Fletcher.
Northampton.. ..	4	1	—	—	3 4 0	" Darra Mair.
Northwich	5	4	14 4 0	33 14 0	89 14 0	" Wheaton.
Norwich	1	1	—	—	163 5 0	" Copeman.
Ormskirk	9	8	5 17 0	30 18 0	88 8 0	Dr. Wheaton.
Oundle	4	4	1 1 0	11 5 0	24 18 0	" Darra Mair.
Oxford (L.A.).. ..	1	1	—	—	56 9 0	Mr. Royle.
Penrith	6	6	3 11 0	10 19 0	34 10 0	Dr. Manby.
Penzance	5	4	5 1 0	20 16 0	51 6 0	Mr. Royle.
Peterborough.. ..	7	5	2 10 0	39 5 0	68 7 0	Dr. Darra Mair.
Pewsey	5	3	2 7 0	9 6 0	15 4 0	" Mivart.
Pontardawe	3	2	42 10 0	57 8 0	99 18 0	Do.
Pontefract	7	5	8 0 0	55 10 0	123 13 0	" Johnstone
Pontypridd	11	7	20 2 0	68 5 0	306 9 0	" Mivart.
Poole	4	2	3 19 0	27 5 0	31 4 0	Mr. Royle.
Portsmouth	1	1	—	—	109 14 0	" Bulstrode.
Pwllheli..	6	1	—	—	5 7 0	Dr. Wheaton.
Redruth..	6	3	10 14 0	15 2 0	37 18 0	Mr. Royle.
Rothbury	6	3	0 4 0	4 13 0	8 2 0	Dr. Johnstone.
Runcorn	4	4	5 5 0	34 15 0	69 13 0	" Wheaton.
Saddleworth	1	1	—	—	15 6 0	Dr. Johnstone.
Selby	4	3	0 18 0	16 7 0	24 4 0	Do.
Shaftesbury	4	2	2 5 0	7 15 0	10 0 0	Mr. Royle.
Shardlow	9	6	4 8 0	14 0 0	42 2 0	Dr. Johnstone.
Shepton Mallet ..	5	4	0 14 0	9 15 0	15 10 0	Mr. Royle.
Sherborne	3	2	2 11 0	5 19 0	8 10 0	Do.
Shifnal	4	2	5 19 0	9 14 0	15 13 0	Dr. Reece.

App. A, No. 5.

Inspection of Vaccination and Awards to Public Vaccinators, 1901.

UNION.	No. of Vaccination Districts in the Union.	No. of Public Vaccinators recommended for Award.	Range of Awards in each Union. Minimum.	Range of Awards in each Union. Maximum.	Total Sum awarded in each Union.	Medical Inspector.
			£ s. d.	£ s. d.	£ s. d.	
Sleaford	7	2	3 3 0	3 15 0	6 18 0	Dr. Copeman.
Spalding	7	3	6 1 0	7 10 0	19 16 0	Do.
Stafford	4	—	—	—	—	„ Reece.
Staines	7	5	5 10 0	16 4 0	55 7 0	„ Fletcher.
Stockport	6	6	9 2 0	57 12 0	165 14 0	„ Wheaton
Stoke-upon-Trent ..	5	3	7 7 0	42 14 0	92 10 0	„ Reece.
Stone	4	2	1 19 0	6 18 0	8 17 0	Do.
Stratton..	2	2	2 18 0	6 8 0	9 6 0	Mr. Royle.
Sturminster	4	4	4 7 0	8 17 0	22 13 0	Do.
Swaffham	5	1	—	—	2 7 0	Dr. Copeman.
Swansea	6	2	32 11 0	70 7 0	102 18 0	„ Mivart.
Swindon and Highworth.	4	3	5 17 0	39 1 0	51 9 0	Do.
Tadcaster	5	2	0 9 0	18 3 0	18 12 0	Dr. Johnstone.
Tamworth	3	2	2 13 0	11 3 0	13 16 0	„ Reece.
Taunton	7	7	1 7 0	25 9 0	51 1 0	Mr. Royle.
Thame	6	4	0 11 0	11 5 0	22 0 0	Do.
Thanet, Isle of ..	4	4	6 14 0	45 7 0	95 10 0	Dr. Reece.
Thetford	6	5	0 19 0	12 18 0	45 9 0	„ Copeman.
Thrapston	5	5	1 3 0	6 6 0	17 1 0	„ Darra Mair.
Tisbury	3	1	—	—	4 0 0	„ Mivart.
Toxteth Park	2	2	24 17 0	29 13 0	54 10 0	„ Sweeting.
Truro	7	4	2 4 0	11 10 0	22 18 0	Mr. Royle.
Tynemouth	10	7	9 1 0	56 19 0	256 10 0	Dr. Johnstone.
Trowbridge and Melksham.	2	1	—	—	5 1 0	„ Mivart.
Uckfield	6	6	0 11 0	5 10 0	22 7 0	Dr. Thomson.
Ulverston	7	5	1 0 0	20 17 0	42 2 0	„ Wheaton
Uttoxeter	5	3	2 0 0	5 1 0	10 19 0	„ Reece.
Uxbridge	7	7	3 11 0	19 12 0	63 15 0	„ Fletcher.
Wakefield	6	6	8 19 0	84 13 0	233 18 0	Dr. Johnstone.
Walsall	4	4	11 2 0	64 14 0	139 7 0	„ Reece.
Walsingham	5	2	4 18 0	15 3 0	20 1 0	„ Copeman

UNION.	No. of Vaccination Districts in the Union.	No. of Public Vaccinators recommended for Award.	Range of Awards in each Union.		Total Sum awarded in each Union.	Medical Inspector.
			Minimum.	Maximum.		
			£ s. d.	£ s. d.	£ s. d.	
Wareham and Purbeck.	6	5	2 17 0	10 11 0	32 11 0	Mr. Royle.
Warminster	5	5	2 10 0	11 4 0	23 12 0	Dr. Mivart.
Wayland	2	1	—	—	17 16 0	" Copeman.
Wellingborough ..	5	3	1 17 0	7 6 0	11 12 0	" Darra Mair.
Wellington (Salop) ..	3	2	24 2 0	33 18 0	58 0 0	" Reece.
Wellington (Som.) ..	6	5	3 10 0	8 14 0	25 13 0	Mr. Royle.
Wells	4	4	2 7 0	8 3 0	22 2 0	Do.
Wem	4	3	4 2 0	10 19 0	22 11 0	Dr. Reece.
West Bromwich ..	6	2	27 13 0	28 7 0	56 0 0	Do.
Westbury and Whorwellsdown.	4	2	1 11 0	7 13 0	9 4 0	" Mivart.
West Ward	4	4	2 15 0	5 8 0	16 0 0	" Manby.
Weymouth	6	6	0 12 0	28 10 0	51 16 0	Mr. Royle
Whitehaven	6	3	4 0 0	60 15 0	171 3 0	Dr. Manby
Wigton	7	6	1 8 0	13 8 0	41 7 0	Do.
Willesden	2	1	—	—	69 11 0	" Fletcher.
Williton	7	4	0 15 0	7 8 0	15 1 0	Mr. Royle.
Wilton	4	4	3 0 0	7 5 0	18 5 0	Dr. Mivart.
Wimborne and Cranborne.	4	4	4 5 0	11 13 0	36 0 0	Mr. Royle.
Wincanton	6	5	3 3 0	8 2 0	25 1 0	Do.
Winslow .. .	3	3	2 4 0	3 7 0	7 17 0	Dr. Fletcher.
Wirral	5	3	6 9 0	18 4 0	38 17 0	" Wheaton.
Wolstanton and Burslem.	3	3	39 0 0	40 13 0	119 6 0	" Reece.
Woodstock	4	2	10 1 0	11 0 0	21 1 0	Mr. Royle.
Woolwich	4	1	—	—	6 11 0	Dr. Sweeting.
Wycombe	11	7	3 0 0	16 5 0	52 17 0	" Fletcher.
Yeovil	7	6	1 15 0	18 18 0	40 2 0	Mr. Royle.
Total	1,215	866	—	—	10,584 16 0	

App. A, No 6

National Vaccine Establishment, 1901.

No. 6.

STATISTICS OF THE NATIONAL VACCINE ESTABLISHMENT.

I.—Educational Vaccination Stations, 1901.

In order to provide for the granting of those special certificates of proficiency in vaccination which are required to be part of the medical qualification for entering into contracts for the performance of public vaccination, or for acting as deputy to a contractor, the following arrangements are made :—

(1.) The vaccination stations enumerated in the subjoined list are open, under certain specified conditions, for the purposes of teaching and examination ;

(2.) The vaccinators officiating at these stations are authorised to give the required certificates of proficiency in vaccination to persons whom they have sufficiently instructed therein ; and

(3.) The vaccinators whose names in the subjoined list are printed in *italic letters* are also authorised to give such certificates, after satisfactory examination, to persons whom they have not themselves instructed.

Cities and Towns having Educational Vaccination Stations.	Places used as Educational Vaccination Stations.	Vaccinators authorised to give Certificates of Proficiency in Vaccination.	Days and Hours of Attendance of the Vaccinators at Stations where periodic Courses of Instruction are given. (*a*)
London ...	St. Thomas's Hospital, Westminster Hospital	Dr. Albert Ernest Cope, 26, Bessborough Gardens, S.W.	Wed., 11. Thursday, 11.
	Tottenham Court Chapel, Tottenham Court Road.	*Mr. Joseph Loane* ... 98, Tressillian Road, St. John's, S.E.	Mon., Wed., 1.
	St. Mary's Hospital, Middlesex Hospital, St. George's Hospital	Mr. Edwin Climson Greenwood, 19, St. John's Wood Park, N.W.	Tuesday, 11. Friday, 3. Wed., 3.
	26, Bessborough Gardens, S.W.	Dr. Albert Ernest Cope, 26, Bessborough Gardens, S.W.	Mon., Thurs., 3.
	St. Olave's and St. John's Institute, Tooley Street, S.E.	Mr. Victor Alexander Jaynes, 157, Jamaica Road, Bermondsey, S.E.	Wed., 3.
	Eastern Dispensary, Leman Street.	Mr. Joseph Loane ... *See* above.	Wed., 11.
	144, Euston Road, N.W.	Miss Mary Thorne, M.D., 10, Nottingham Place, W.	Friday, 9.

(*a*) Candidates for the *Certificate after Instruction* should communicate with the authorised teacher to learn the dates of the regular courses of instruction.

Candidates for the *Certificate by Examination* are recommended to communicate some days beforehand with the Examiner at whose station they propose to attend.

I.—Educational Vaccination Stations—*continued.*

Cities and Towns having Educational Vaccination Stations.	Places used as Educational Vaccination Stations.	Vaccinators authorised to give Certificates of Proficiency in Vaccination.	Days and Hours of Attendance of the Vaccinators at Stations where periodic Courses of Instruction are given. (a)
Birmingham	Priory Rooms, Upper Priory.	*Dr. Edmund Robinson*... 213, Bristol Road, Edgbaston, Birmingham.	Monday 1.30.
Bristol ...	St. Peter's Hospital, Bristol.	*Mr. George Shepley Page*, 78, Old Market Street, Bristol.	Wed., 11.
Cambridge..	East Road Coffee Tavern.	Mr. Joseph Lcane ... *See* above.	Friday, 11.
Cardiff ...	Roath Church Institute, Sun Street, Roath.	*Mr. John Llewellyn Treharne*, 92, Newport Road, Cardiff.	Tuesday, 11.
Leeds ...		(Vacant.)	
Liverpool ...	177, Mulgrave Street	*Mr. Nathaniel Edward Roberts*, 33, Mulgrave Street, Liverpool.	Tuesday, 3.
Manchester	Southern Hospital for Women and Children, Manchester.	Dr. John Scott ... ... 249, Upper Brook Street, Manchester.	Friday, 2.
Newcastle-on-Tyne.	The Dispensary, Nelson Street.	*Dr. Frank Hawthorn* ... 6, Regent Terrace, Newcastle-on-Tyne.	Wed., 3.
Sheffield ...	250, Brook Hill, Sheffield.	*Mr. William Skinner* ... 250, Brook Hill, Sheffield.	Tuesday, 3
Aberdeen ...	The Public Dispensary.	*Mr. Robert Gordon McKerron*, 1, Albyn Place, Aberdeen.	Wed., 2.30.
Dundee ...	Royal Infirmary ...	Dr. Robert Cochrane Buist, 166, Nethergate, Dundee.	Thursday, 2.
Edinburgh	The Western Dispensary, Ponton Street.	*Dr. John Brown Buist*, 1, Clifton Terrace, Edinburgh.	Thursday, 3.
Edinburgh	The New Town Dispensary.	Dr. Francis Cadell ... 22, Ainslie Place, Edinburgh.	Tuesday, 12.

(a) Candidates for the *Certificate after Instruction* should communicate with the authorised teacher to learn the dates of the regular courses of instruction.

Candidates for the *Certificate by Examination* are recommended to communicate some days beforehand with the Examiner at whose station they propose to attend.

I.—Educational Vaccination Stations—*continued.*

Cities and Towns having Educational Vaccination Stations.	Places used as Educational Vaccination Stations.	Vaccinators authorised to give Certificates of Proficiency in Vaccination.	Days and Hours of Attendance of the Vaccinators at Stations where periodic Courses of Instruction are given. (*a*)
Glasgow ...	The Royal Infirmary	*Mr. Robert Home Henderson*, 19, Elmbank Place, Glasgow.	Monday, 12 (Women). Thursday, 12. (Men).
	The Western Infirmary.	Mr. John Wyllie Nicol, 7, Kersland Terrace, Glasgow.	Monday, 12.
Dublin ...	45, Upper Sackville Street.	*Dr. Alexander Nixon Montgomery*, 45, Upper Sackville Street, Dublin.	Tues., Fri., 10.

(*a*) Candidates for the *Certificate after Instruction* should communicate with the authorised teacher to learn the dates of the regular courses of instruction.

Candidates for the *Certificate by Examination* are recommended to communicate some days beforehand with the Examiner at whose station they propose to attend.

II.—Animal Vaccine Station.

The Animal Vaccine Station is at 95, Lamb's Conduit Street, where Mr. T. S. Stott and Dr. Leslie Thorne Thorne attend for the Vaccination of Children on Tuesdays and Thursdays at 10.30 a.m.

III.—Distribution of Glycerinated Calf Lymph, 1901.

Number of applications from Public Vaccinators ... 66,670

Supplies sent out :—

Charged capillary tubes 654,907

No. 7.

REPORT on the OPERATIONS of the ANIMAL VACCINE ESTABLISHMENT at LAMB'S CONDUIT STREET during the year 1901–1902; by Mr. THOMAS S. STOTT, Director.

During the year April 1st, 1901, to March 31st, 1902, 123 calves were vaccinated. The aggregate weight on reception at Lamb's Conduit Street of the 123 calves was 35,264 lbs. On dismissal from the station their aggregate weights were 36,041 lbs., so that during retention for vaccination purposes they gained in weight by an average of 6·31 lbs. Of the above calves, 115 were vaccinated direct from other calves and 8 were vaccinated from calf lymph which had been stored. As usual, vaccinations performed with direct lymph proved more successful than the others.

Insertions to the number of 5,907 in calf-to-calf operations produced 5,675 vesicles, in the 8 calves vaccinated from lymph stored in tubes, 441 insertions produced 228 vesicles, giving rates of insertion respectively of 96·07 and 51·70 per cent.

No material difference in the results of calf-to-calf vaccinations was observed, whether the lymph used was from calves vaccinated 96 hours or from calves vaccinated 120 hours previously; in either case the rate of insertion success was practically 96 per cent.

Primary Vaccinations.—During the year 1901-1902 there were performed 2,786 primary vaccinations, five separate insertions of lymph being made in each instance. Of the persons thus vaccinated, 1,362 were males and 1,424 were females. All but 11 of the primary vaccinations succeeded at the first attempt.

There were 657 primary vaccinations performed from calf-to-arm. Of these persons primarily vaccinated by the staff operators, 13 failed to return for inspection. Of the 644 remaining, 614 on examination were found to have taken in five places, 23 in four, 5 in three, and 2 in two places.

The aggregate insertion success was therefore 98·78 per cent.

Glycerinated Calf Lymph.—During the same period 2,129 primary vaccinations were performed with glycerinated calf lymph. Of these, 33 failed to return for inspection, and of the remaining 2,096, on examination, 1,802 were found to have taken in five places, 160 in four, 67 in three, 36 in two, 20 in one, and 11 failed at the first attempt.

The insertion success rate, therefore, was 94·87 per cent.

Re-vaccinations.—These numbered 1,045, of which 832 were performed from calf-to-arm, of which cases 20 failed to return for inspection. Of the remaining 812 cases, 728 on inspection were successful in five places, 66 in four, 11 in three, 4 in two, and 3 in one place, giving an insertion success rate of 97·24 per cent.

Glycerinated Calf Lymph.—The other 213 revaccinations were performed with glycerinated calf lymph, of which cases 12 failed to return for inspection. Of the remaining 201 cases, 185 on inspection were successful in five places, 8 in four, 4 in three, 2 in two, 1 in one, and 1 failed, giving an insertion success rate of 96·91 per cent.

There were 25 cases brought back after inspection on account of some abnormality in the course of their vaccination; in the majority of these the abnormality consisted of sore arm, in most instances due to domestic maltreatment.

In September, 1901, the progress of the small-pox epidemic caused such increase in the number of applicants for vaccination and re-vaccination that the clerical staff had to be strengthened, and the applicants were so numerous that re-vaccination was discontinued by order of the Board, and it became necessary to requisition police assistance to maintain order and prevent accidents. This condition continued until March 6th, 1902, when the diminished number of applicants rendered the aid of police no longer needful. During this time all applicants for re-vaccination were referred by the police to the public vaccinators of the districts in which they resided

No. 8.

REPORT on the OPERATIONS of the GLYCERINATED CALF LYMPH ESTABLISHMENT, 1901-1902; by Dr. FRANK R. BLAXALL.

APP. A, No. 8.

On the Operations of the Glycerinated Calf Lymph Establishment, 1901-1902; by Dr. Blaxall.

During the year the work of the Department has been very much increased by the outbreak of small-pox in London and its vicinity.

So heavy were the demands for lymph that it became necessary to extend the Establishment at short notice. Accordingly extra stabling accommodation adjoining the existing calf station was acquired in October, 1901, and again in January, 1902. Two more laboratories were occupied by the department at the Jenner Institute of Preventive Medicine, and the staff was increased by—

1 Assistant Bacteriologist,
1 Medical assistant to help in the vaccination of calves,
7 Laboratory boys,
6 Calf attendants,
1 Clerk.

Small-pox continuing to increase, it was deemed imperative to limit the issue of lymph for re-vaccinations mainly to districts in which small-pox was prevalent. Limitations, in this sense, of the Establishment's operations took effect from 20th January to 6th March. Meanwhile, additional accommodation was sought which might serve as an auxiliary calf station. Such a station has been found and made ready, as an emergency measure, at Peckham.

The amount of glycerinated calf lymph despatched during the year ending March 31st, 1902, was equivalent to 974,595 capillary tubes, each containing sufficient lymph for one vaccination. Table I. shows the amount of lymph despatched in each week of the year. This quantity, however, was not all despatched in single charges. Some was sent out in tubes containing sufficient for 10 or for 25 vaccinations. This method of issue relieved the pressure to some extent on the staff engaged in tubing and despatching the single charges, and has been found especially convenient for the re-vaccination of groups of persons at stations, places of business, and the like. The issue of glycerinated lymph in this way was commenced in October, 1901.

Table II. shows, *inter alia*, the amounts sent out weekly in this way, estimated as single charges: 110,050 in tubes sufficient for 10 vaccinations and 49,775, in tubes sufficient for 25 vaccinations.

The results of the use of the lymph during the year for the 943,839 cases of which report has been sent in show 98·1 per cent. case success and 93·3 per cent. insertion success. The primary vaccinations numbered 510,661, giving a case success of 98·6 per cent. and an insertion success of 93·5 per cent. The re-vaccinations numbered 433,178, giving a case success of 97·6 per cent. and an insertion success of 92·9 per cent.

Table III. shows these results given quarterly.

APP. A, No. 8.

On the Operations of the Glycerinated Calf Lymph Establishment, 1901-1902; by Dr. Blaxall.

The lymph thus issued was derived from 691 calves. All these animals, after slaughter, were examined by the Board's veterinary surgeon and certified to be healthy. Nine other calves which appeared to be in health during the course of vaccination, were found at the autopsy to exhibit evidence of slight disease. None of the lymph from these calves was issued.

The bacteriological examinations of the lymph have been systematically carried out as heretofore, but owing to the great pressure on the establishment, the continuance of the work on the subjects detailed in the last report, and the carrying out of investigations on allied matters, has been in great measure checked.

Mr. H. S. Fremlin contributes a note on an apparatus employed for anaërobic plate culture, which has given very satisfactory results. Dr. A. B. Green has pursued his researches on the action of certain chemicals on the extraneous and specific organisms of lymph, with especial reference to bodies allied to glycerine, and to chloroform. I add a short note on Equine Variola the material, for which I am indebted to Mr. Ernest Crompton, M.R.C.S.

These reports appear in Appendix C.

TABLE I.

Showing amount of GLYCERINATED CALF LYMPH sent from LABORATORIES to NATIONAL VACCINE ESTABLISHMENT for DISTRIBUTION to PUBLIC VACCINATORS during the year ended 31st March, 1902, estimated in single charges.

Week ended		Number of charges sent out.	Month.	Number of charges sent out.	Quarter.	Number of charges sent out
1901.						
April	6	5,200				
	13	7,050	April	35,500		
	20	9,200				
	27	9,950				
May	4	10,600				
	11	10,950	May	43,300	Second quarter	24,200
	18	10,550				
	25	7,850				
June	1	8,650				
	8	12,050				
	15	11,650	June	45,400		
	22	11,300				
	29	9,200				

TABLE I—*continued.*

Week ended		Number of charges sent out.	Month.	Number of charges sent out.	Quarter.	Number of charges sent out.
1901. July	6	8,900				
	13	8,800	July	39,600		
	20	8,450				
	27	8,300				
August	3	8,350				
	10	7,900				
	17	9,100	August	38,950	Third quarter	138,470
	4	8,900				
	31	9,850				
September	7	11,370				
	14	12,700	September	59,920		
	21	13,100				
	28	18,550				
October	5	23,250				
	12	21,950	October	106,740		
	19	22,350				
	26	23,940				
November	2	29,475				
	9	28,400				
	16	23,650	November	104,855	Fourth quarter	281,895
	23	21,050				
	30	21,730				
December	7	21,950				
	14	18,825	December	70,300		
	21	14,025				
	28	8,550				
1902. January	4	22,900				
	11	48,650	January	220,000		
	18	80,150				
	25	48,400				
February	1	31,000				
	8	29,295	February	97,695	First quarter	430,030
	15	23,250				
	22	21,980				
March	1	22,530				
	8	29,850				
	15	32,300	March	112,335		
	22	27,200				
	31	19,475				
Totals ..		974,595		974,595		974,595

APP. A, No. 8.

On the Operations of the Glycerinated Calf Lymph Establishment, 1901-1902; by Dr. Blaxall.

TABLE II.

Showing the amount of GLYCERINATED CALF LYMPH sent in CAPILLARY TUBES and in larger quantities to NATIONAL VACCINE ESTABLISHMENT for DISTRIBUTION to PUBLIC VACCINATORS during the year ended 31st March, 1902.

Amount sent out Weekly, represented in Single Charges.				Amount sent out Monthly, represented in Single Charges.				Amount sent out Quarterly, represented in Single Charges.			
Week ended	In Capillary Tubes.	In Tubes sufficient for 10 Vaccinations.	In Tubes sufficient for 25 Vaccinations.	Month.	In Capillary Tubes.	In Tubes sufficient for 10 Vaccinations.	In Tubes sufficient for 25 Vaccinations.	Quarter.	In Capillary Tubes.	In Tubes sufficient for 10 Vaccinations.	In Tubes sufficient for 25 Vaccinations.
1901.											
April 6	5,200	—	—								
13	7,050	—	—								
20	9,200	—	—	April	35,500	—	—				
27	9,950	—	—								
May 4	10,600	—	—								
11	10,950	—	—								
18	10,550	—	—	May	43,300	—	—	Second quarter.	124,300	—	—
25	7,850	—	—								
June 1	8,650	—	—								
8	12,050	—	—								
15	11,650	—	—	June	4[illegible],400	—	—				
22	11,300	—	—								
29	9,200	—	—								
July 6	8,900	—	—								
13	8,800	—	—								
20	8,450	—	—	July	39,600	—	—				
27	8,300	—	—								
Aug. 3	8,350	—	—								
10	7,900	—	—								
17	9,100	—	—	Aug.	38,950	—	—	Third quarter.	138,470	—	—
24	8,900	—	—								
31	9,850	—	—								
Sept. 7	11,370	—	—								
14	12,700	—	—								
21	13,100	—	—	Sept.	59,920	—	—				
28	18,550	—	—								

TABLE II—*continued.*

Amount sent out Weekly, represented in Single Charges.				Amount sent out Monthly, represented in Single Charges.				Amount sent out Quarterly, represented in Single Charges.			
Week ended	In Capillary Tubes.	In Tubes sufficient for 10 Vaccinations.	In Tubes sufficient for 25 Vaccinations.	Month.	In Capillary Tubes.	In Tubes sufficient for 10 Vaccinations.	In Tubes sufficient for 25 Vaccinations.	Quarter.	In Capillary Tubes.	In Tubes sufficient for 10 Vaccinations.	In Tubes sufficient for 25 Vaccinations.
1901.											
Oct. 5	20,200	2,000	1,050								
12	16,850	4,000	1,100								
19	18,100	4,000	250	Oct.	37,350	16,390	3,000				
26	20,250	3,490	200								
Nov. 2	23,100	5,100	1,275								
9	21,750	5,450	1,200								
16	19,150	3,300	1,200	Nov.	85,650	14,780	4,425	Fourth quarter.	236,750	37,170	7,975
23	18,450	2,000	600								
30	19,350	1,830	550								
Dec. 7	19,600	2,350	—								
14	16,700	1,750	375	Dec.	63,750	6,000	550				
21	12,750	1,100	175								
28	7,900	650	—								
1902.											
Jan. 4	21,100	1,750	50								
11	39,200	8,950	500								
18	51,600	19,200	9,350	Jan.	159,500	43,850	16,650				
25	33,600	10,300	4,500								
Feb. 1	24,100	4,250	2,650								
8	22,900	4,370	2,025	Feb.	80,000	12,870	4,825	First quarter.	315,350	72,880	41,800
15	19,400	3,100	750								
22	18,700	2,530	750								
Mar. 1	18,600	2.780	1,150								
8	21,350	3.800	4,700								
15	20,300	4,800	7,200	Mar.	75,850	16,160	20,325				
22	18,000	4,400	4,800								
31	13,300	2,800	3,375								
Totals	814,770	110,050	49,775		814,770	110,050	49,775		814,770	110,050	49,775
	974,595				974,595				974,595		

Table III.

Showing results of the use of Glycerinated Calf Lymph issued during the year ended 31st March, 1902.

Total Cases.

Period during which sent out.	Number of cases used for.	Percentage success.	
		Case.	Insertion.
June Quarter 1901	115,726	98·6	93·2
September „ „	129,758	98·3	92·6
December „ „	269,759	97·9	93·0
March „ 1902	428,596	98·1	93·7
Total	943,839	98·1	93·3

Primary Cases.

Period during which sent out.	Number of cases used for.	Percentage success.	
		Case.	Insertion.
June Quarter 1901	113,324	98·7	93·3
September „ „	113,732	98·6	92·7
December „ „	128,737	98·6	94·0
March „ 1902	154,868	98·5	94·0
Total	510,661	98·6	93·5

Re-vaccinations.

Period during which sent out.	Number of cases used for.	Percentage success.	
		Case.	Insertion.
June Quarter 1901	2,402	95·6	89·6
September „ „	16,026	96·3	91·7
December „ „	141,022	97·3	92·1
March „ 1902	273,728	97·9	93·5
Total	433,178	97·6	92·9

No. 9.

APP. A, No. 9.

Summary of the Work of the Medical Inspectors in 1901.

*SUMMARY of the WORK of the MEDICAL INSPECTORS during the YEAR 1901.

A. DISEASE AND SANITARY ADMINISTRATION.

The following sanitary districts were visited by the Medical Inspectors with special reference to outbreaks of infectious disease of one and another sort, and to general sanitary circumstances and administration, viz. :—

Name of District.	Nature of Inquiry.
†Alcester, R.D.	As to adequacy of salary of Medical Officer of Health, and sanitary state and administration.
Barrow-in-Furness, U.D.	Sanitary administration with reference to small-pox.
Battersea, U.D.	Do. do.
Beckenham, U.D.	Do. do.
Bermondsey, U.D.	Do. do.
Bexley, U.D.	Do. do.
†Bilston, U.D.	Re-inspection to ascertain how far the previous recommendations have been complied with.
Bromley, R.D.	Sanitary administration with reference to small-pox.
Bromley, U.D.	Do. do.
†Brynmawr, U.D.	To ascertain how far the Brynmawr sewage farm, situated in Crickhowell, R.D., was responsible for the prevalence of infectious disease in that district.
†‡Catherington, R.D.	Scarlatina near Ditcham Park Estate (*see also* Petersfield, R.D.).
Chislehurst, U.D.	Sanitary administration with reference to small-pox.
†‡Coventry, U.D.	Enteric fever.
†Crickhowell, R.D.	*See* Brynmawr, U.D.

* Throughout this summary the following abbreviations are used :—U.D. = a Borough or Urban District. R.D. = Rural District. P.S.D. = Port Sanitary District. Jt.H.D. = A Joint District for hospital purposes, formed under the Public Health Act, 1875, or the Isolation Hospitals Act, 1893.

† *See* Appendix A, No. 10, p. 129.

‡ The reports on these districts are reproduced in full in this volume, *see* Appendix A, Nos. 11 to 16.

A. Disease and Sanitary Administration—*continued.*

Name of District.	Nature of Inquiry.
Dartford, R.D.	Sanitary administration with reference to small-pox.
Dartford, U.D.	Do. do.
†Darwen, U.D.	Diphtheria.
Edmonton, U.D.	Sanitary administration with reference to small-pox.
Erith, U.D.	Do. do.
†‡Falmouth, U.D.	Re-inspection as to sanitary state and administration.
Finsbury, U.D.	Sanitary administration with reference to small-pox.
†‡Folkestone, U.D.	Enteric fever; sanitary state and administration.
†Gildersome, U.D.	Do. do.
Hackney, U.D.	Sanitary administration with reference to small-pox.
†‡Haverfordwest, R.D.	Diphtheria at Fishguard and Goodwick.
Holborn, U.D.	Sanitary administration with reference to small-pox.
†Holsworthy, U.D.	Sanitary state and administration.
†Lancaster, R.D.	Do. do.
†Llandilo Fawr, R.D.	Prevalence of infectious disease; sanitary state and administration.
London, City of	Sanitary administration with reference to small-pox.
†Lydd, U.D.	Sanitary state and administration.
†Milton, R.D.	Prevalence of infectious disease; sanitary state and administration.
†Milton-next-Sittingbourne, U.D. ...	Do. do.
†New Romney, U.D.	Sanitary state and administration.
Orsett, R.D....	Sanitary administration with reference to small-pox.
†Petersfield, R.D.	*See* Catherington, R.D.
†Pewsey, R.D.	Sanitary state of Ludgershall.
†Prestwich, U.D.	Sanitary state and administration.
†Romney Marsh, R.D.	Do. do.
†St. Helens (I. of W.), U.D.	Do. do.
St. Marylebone, U.D.	Sanitary administration with reference to small-pox.

† *See* Appendix A, No. 10, p. 129.
‡ The reports on these districts are reproduced in full in this volume, *see* Appendix A, Nos. 11 to 16.

A. Disease and Sanitary Administration—*continued*.

Name of District.	Nature of Inquiry.
St. Pancras, U.D.	Sanitary administration with reference to small-pox.
†Sittingbourne, U.D.	Prevalence of infectious disease; sanitary state and administration.
†Spalding, R.D.	Appointment of Medical Officer of Health; sanitary state and administration.
Stoke Newington, U.D.	Sanitary administration with reference to small-pox.
†Strood, R D.	Sanitary state and administration; prevalence of infectious disease.
Tottenham, U.D.	Sanitary administration with reference to small-pox.
West Ham, U.D.	Do. do.
†‡Weymouth and Melcombe Regis, U.D....	Scarlatina; sanitary state and administration.
†‡Whitehaven, U.D....	Enteric fever.

B. Hospitals, &c.

Local inquiries were held by the Medical Inspectors with reference to the provision of hospital accommodation for the isolation of cases of infectious disease in connection with the districts mentioned below. The majority of these inquiries had concern with applications to the Local Government Board for sanction to borrow money for the purchase of hospital sites and for the erection of hospital buildings:—

Acton, U.D.
Ashford, U.D
Barnet, U.D.
Barnsley, U.D.
Bedford, R.D.
Berwick-upon-Tweed, U.D.
Bexhill, U.D.
Biggleswade, R.D. and U.D.
Blackburn, U.D.
Buckhurst Hill, U.D., Chingford, U.D., and Waltham Holy Cross, U.D.
Caistor, R.D.
Colne and Holme, Jt.H.D.
Colwyn Bay and Colwyn, U.D.
Cuckfield, R.D.
Doncaster and Mexborough, Jt.H.D.
East and West Molesey, U.D.
East Barnet Valley, U.D.
Edmonton, U.D.
Enfield, U.D.
Fareham, U.D.
Fylde, Jt.H.D.
Fylde, Preston, and Garstang, Jt.H.D.
Gwyrfai, R.D.
Halifax, U.D.
Hanley, Stoke, and Fenton, Jt.H.D.
Harrogate and Knaresborough, Jt.H.D.
Hemsworth, R.D.

† *See* Appendix A, No. 10, p. 129.
‡ The reports on these districts are reproduced in full in this volume, *see* Appendix A, Nos. 11 to 16.

B. HOSPITALS, &c.—*continued*

Hendon, R.D.
Hitchin, Jt.H.D.
Horwich, Westhoughton, and Blackrod, Jt.H.D. (2 inquiries).
Ilford, U.D.
Ilfracombe, U.D.
Littleborough, Milnrow, and Wardle, Jt.H.D.
Llandaff and Dinas Powis, R.D.
Maesteg, Jt.H.D.
Maldon, Jt.H.D.
Manchester, U.D.
Nantwich, Jt.H.D.
Normanton, Jt.H.D.
Northwich, Middlewich, and Winsford, Jt.H.D.
Orsett, Jt.H.D.
Penistone, Jt.H.D.
Pontardawe, Jt.H.D.
Pontypridd, U.D.
Portsmouth, U.D.
Preston, Fulwood, and Longridge, Jt.H.D.
Radcliffe, Ramsbottom, Whitefield, and Bury, Jt.H.D.
Reading, U.D.
Reigate, U.D.
Repton, Jt.H.D.
Rhyl, U.D.
Rochester and Chatham, Jt.H.D.
Rothwell, Methley, and Hunslet, Jt.H.D.
Royston, Ashwell, and Melbourn, Jt.H.D.
Sevenoaks, U.D.
Skegness, U.D.
Southend-on-Sea, U.D.
Southport, U.D.
South Rotherham, Handsworth, and Kiveton Park, Jt.H.D.
Stratford-on-Avon, R.D. and U.D., and Marston Sicca, R.D.
Trowbridge, Jt.H.D.
Ulverston, Jt.H.D.
Uxbridge, Jt.H.D.
Wakefield, U.D.
Wallasey, U.D.
Walthamstow, U.D.
Warrington, U.D.
Watford, Jt.H.D.
Wath, Swinton, Greasborough, and North Rotherham, Jt.H.D.
Widnes, U.D.
Willesden, U.D.
Wirral, Jt.H.D.

Inquiries as to the provision of mortuary accommodation were held at Birkenhead, Wimbledon, and East Barnet Valley Urban Districts; for a disinfecting station and ambulance shed at Finchley Urban District; and as to the provision of a temporary shelter for the accommodation of persons while their homes were disinfected at Shoreditch. An inquiry as to the issue of a provisional order for the dissolution of the Upton-on-Severn and Pershore Joint Hospital District was also held.

Dr. Buchanan presided at a conference of representatives of the Essex County Council and Chingford, Woodford, Buckhurst Hill, and Waltham Holy Cross Urban District Councils with reference to the formation of a Joint Hospital District.

C. SEWERAGE AND SEWAGE DISPOSAL.

Inquiries in this connection were held at:—

Gainsborough, U.D.
Newcastle-under-Lyme, U.D.
Wetherby, R.D.

D. WATER SUPPLY.

Medical Inspectors were associated with Engineering Inspectors of the Board in inquiries at :—

Llanelly, R.D.
Do. U.D.
Tenby, U.D.

E. SCAVENGING, &c.

Inquiries of one and another sort concerning the removal of refuse, and the proper cleansing of privies, cesspools, and ashpits, were held in—

Bakewell, R.D.
Lunesdale, R.D.
Shardlow, R.D.
Southend-on-Sea, U.D
Stanhope, U.D.
Tadcaster, R.D.

F. BYELAWS.

Inquiries with regard to the adoption of a suitable code of byelaws were held in connection with the following districts :—

Epsom, R.D.
Hornsey, U.D.
South Shields, U.D.
Sunderland, U.D.

G. VACCINATION INSPECTION.

In addition to the routine inspection of vaccination in England and Wales (App. A, No. 5), special visits by Medical Inspectors with reference to vaccination administration were made to the Unions mentioned below. The visits to those Unions indicated in italics were made owing to the prevalence of small-pox in the Union.

Bethnal Green.
Blaby.
Bromley.
Camberwell.
Cambridge.
Dartford.
Dudley.
Durham.
Eastbourne.
Edmonton.
Freebridge Lynn.
Gloucester.
Hackney.
Hampstead.
Holborn.
Isles of Scilly.
Keighley.
King's Lynn.
Kingston-on-Thames.
Leicester.
Mile End,
Mitford and Launditch.
Newhaven.
Northampton.
Paddington.
Pontardawe.
Poole.
Poplar.
Rochdale.
St. Giles and St. George, Bloomsbury.
St. Marylebone.
St. Olave.
St. Pancras
Shoreditch.
Uckfield.
Wandsworth and Clapham.
West Ham.
Willesden.
Wolstanton and Burslem.

APP. A, No. 9.

Summary of the Work of the Medical Inspectors in 1901.

H. Plague Precautions.

It having come to the knowledge of the Medical Department that there was a recrudescence of plague in Portugal, the Medical Inspectors were instructed to visit the Port Sanitary Authorities in England and Wales having shipping trade with that country.

In this connection the following ports were visited :—

Bridgwater.
Bristol.
Cardiff.
Falmouth and Truro.
Fowey.
Gloucester.
Liverpool.
Newport (Mon.).
Plymouth.
River Blyth.
" Tees.
" Tyne.
Sunderland.
Swansea.
Weymouth.

The Medical Inspectors also visited certain of the sanitary areas in the suburbs of the Metropolis with a view to ascertaining that each district was properly equipped to enable it to deal with any cases of plague that might be imported into the district. The Inspector in each instance conferred with the responsible officers and advised them as to the best course to be adopted in such an emergency.

Districts visited :—

Acton, U.D.
Beckenham, U.D.
Brentford, U.D.
Bromley, U.D.
Chislehurst, U.D.
Chiswick, U.D.
Croydon, R.D.
Do. U.D.
Ealing, U.D.
Hendon, U.D.
Hornsey, U.D.
Tottenham, U.D.
West Ham, U.D.
Willesden, U.D.
Wimbledon, U.D.

Cases or suspected cases of plague were locally investigated at :—

Ealing, U.D.
Hull, P.S.D.
Islington, U.D.
Liverpool, U.D.
Plymouth, P.S.D. (2 cases).
Southampton, P.S.D.
Willesden, U.D.

I. Conferences with Local Officials.

Conferences on sanitary matters were held locally with various officials of the following districts :—

Barton Regis, R.D.
Bermondsey, U.D.
Bilston, U.D.
Chailey, R.D.
Gravesend, U.D.
Holsworthy, R.D.
Kendal, U.D.
Liverpool, U.D.
London, City of.
Poplar, U.D.
Portsmouth, P.S.D.
Stanhope, U.D.
River Tyne, P.S.D.
Workington, U.D.

K. Miscellaneous.

Dr. Bulstrode inquired respecting nuisance ascribed to sea-weed at East Cowes, U.D., and has also continued from time to time his re-inspection of oyster layings round the coast, and the position of shell-fish beds and layings generally as to their liability to pollution by sewage.

Dr. Thomson has been associated with other Officers of the Board in holding public inquiries into an application of the Borough of Rotherham for a provisional order constituting the borough a county borough, and as to an application of the London water companies for new water regulations. He has also as occasion offered continued a general inquiry into the conditions of endemic prevalence of enteric fever in certain sanitary districts.

Inquiries have been held with reference to the constitution of Port Sanitary Authorities for Manchester and New Shoreham.

An investigation was made by Dr. Mair as to cancelling a licence for burial in a vault under the church floor at St. Nicholas church, Guildford.

Dr. Manby has been employed on an inquiry in various districts as to the suitability of the Board's model series of Regulations as to Dairies, Cow-sheds, and Milk-shops, for adoption by local authorities under Art. 13 of the Dairies, Cow-sheds, and Milk-shops Order of 1885, according as the area is urban, semi-urban, or rural. In the course of his inquiry he visited—

Accrington, U.D.	Hayfield, R.D.
Bath, R.D.	Hyde, U.D.
Bath, U.D.	Kendal, U.D.
Blackburn, R.D.	Kirkheaton, U.D.
Bolton, U.D.	Little Lever, U.D.
Burnley, U.D.	Manchester, U.D.
Chapel-en-le-Frith, R.D.	Prescot, U.D.
Chester, R.D.	Prestwich, U.D.
Chester, U.D.	Urmston, U.D.
Cirencester, R.D.	Wilmslow, U.D.
Cirencester, U.D.	

L. Inquiries by the Assistant Inspector in the Medical Department.

Mr. Huddart, during the year, inquired into the conditions of appointment of Inspectors of Nuisances in the following districts:—

Axminster, R.D.	Caerleon, U.D.
Barton Regis, R.D.	Cheshunt, U.D.
Belper, R.D.	Chesterfield, R.D.
Blyth and Cuckney, R.D.	Clun, R.D.
Bourne, R.D.	Durham, U.D.
Branksome, U.D.	Fairfield, U.D.
Bucklow, R.D.	Gelligaer and Rhigos, R.D.
Burnham-on-Crouch, U.D.	Godstone, R.D.

App. A, No. 9.

Summary of the Work of the Medical Inspectors in 1901.

L. INQUIRIES BY THE ASSISTANT INSPECTOR—*continued.*

Helmsley, R.D.	Petworth, R.D.
Kidsgrove, U.D.	Plomesgate, R.D.
Llantrisant and Llantwit Vardre, R.D.	Riccall, R.D.
Maidenhead, U.D.	Scarborough, R.D.
Midhurst, R.D.	Stanley, U.D.
Northam, U.D.	Waltham Holy Cross, U.D.

Mr. Huddart also visited the Unions named below as to the administration of the Vaccination Acts, and especially as to the performance of duty by the Vaccination Officers :—

Abingdon.	Newark.
Barnstaple.	Nottingham.
Basford.	Orsett.
Bedford.	Oswestry.
Birkenhead.	Reading.
Birmingham.	Royston.
Cardiff.	Rugby.
Clun.	Ruthin.
Colchester.	Saddleworth.
Daventry.	St. Asaph.
Dudley.	Scarborough.
East Retford.	Southwell.
Fylde.	Stoke-on-Trent.
Glossop.	Tarvin.
Great Yarmouth.	Tewkesbury (2).
Holyhead.	Towcester.
Holywell.	Wallingford.
King's Lynn.	Wellington (Salop).
King's Norton.	West Bromwich.
Maidenhead.	Windsor.
Mansfield.	Wokingham.

No. 10.

ABSTRACT of MEDICAL INSPECTIONS made in 1901 with regard to the INCIDENCE of DISEASE on particular places, and to questions concerning LOCAL SANITARY ADMINISTRATION.

[*The reports relating to districts indicated by an asterisk are reproduced in this volume, see App. A, Nos.* 11 *to* 16.]

1. ALCESTER RURAL DISTRICT (WARWICK); population (1891), 11,483; Dr. S. Monckton Copeman.

Authority concerned: Alcester Rural District Council.

Ground of Inquiry: Question as to adequacy of remuneration paid by the Rural District Council to their Medical Officer of Health, rendering necessary inquiry into general sanitary circumstances and administration of the district.

Chief Facts reported by Inspector: Both diphtheria and scarlet fever prevalent in district during last two years, but of somewhat mild type. Spread of these diseases favoured by impossibility of obtaining proper isolation accommodation.

Except at Alcester and Crabb's Cross, water supply from shallow wells imperfectly protected against pollution. Public water supply at Alcester very deficient in quantity. Sewerage system for excremental matters at Alcester only. Defective scavenging arrangements in rural portions of district. More efficient supervision of slaughter-houses and bakehouses desirable.

Hospital provision insufficient; no disinfecting apparatus. Council well advised by Medical Officer of Health whose remuneration must be considered as inadequate in view of the local circumstances and of the work done by him.

2. BILSTON URBAN DISTRICT (STAFFORD); population (1901), 24,034; Dr. W. W. E. Fletcher.

Authority concerned: Bilston Urban District Council.

Ground of Inquiry: The district was inspected by Dr. Darra Mair during 1899, and on his report the Board made certain formal recommendations to the District Council. The Board desired to ascertain whether these recommendations were, or were not, being complied with.

Chief Facts reported by Inspector: The Board's recommendations had reference to the following matters. The

subject of each recommendation is immediately followed by the answer—abbreviated—found to be applicable :—

"1. The paving and draining of back-yards." No great progress, but work progressing.

"2. Provision of rain-water gutters and spouts where needful." Little has been done.

"3. Completion of the sewerage of the district, and the provision of efficient means of sewage disposal." No structural work done. Land for sewage-treatment purchased provisionally.

"4. The abolition of privy-middens and vaults causing nuisance, and their replacement by closets of improved kind." No serious action has thus far been taken.

"5. The substitution of small dry ashpits, or movable bins, for large, wet, and offensive ashpits, and the more frequent removal of refuse." No evidence of action.

"6. The provision of an adequate isolation hospital and disinfecting apparatus." Nothing has been done.

"7. Rearrangement of the work of the Inspector of Nuisances so that that officer may be relieved of the supervision of the scavengers." In practice he still supervises the scavengers.

"8. The more frequent inspection of the district by the Medical Officer of Health." The reply to this is doubtful in character. No evidence on which to base an affirmative, or a negative, answer.

3. *COVENTRY (WARWICK); population (1901), 68,877; Dr. L. W. Darra Mair.

Authority concerned: Coventry Town Council.

Ground of Inquiry: Outbreak of enteric fever.

Chief Facts reported by Inspector: Sudden outbreak of enteric fever limited almost entirely to one street and its "courts," and attributed by the Medical Officer of Health to habit of children playing in river flowing past one of the courts. About half the houses, however, in the affected area obtained drinking water, wholly or partially, from a particular well; 45 per cent. of these houses were invaded with enteric fever, and, until the outbreak reached its maximum, houses other than those so supplied were not invaded. The physical circumstances of the well the reverse of satisfactory, though chemical analysis of its water made some time previously to the epidemic had failed to reveal pollution. Water in this well subjected to exceptional risk of contamination for a short time some three weeks before the epidemic. A pipe trench was made, and remained open for a few days,

close to the well, and nearly opposite to a house containing a case of enteric fever. House slops were habitually thrown on the surface near the well. Heavy rainfall (1½ inches in two days) following a period of hot drought occurred while the trench was open. Chemical analyses of water taken from the well three or four weeks after these occurrences, when the epidemic was beginning to subside, revealed, as might have been anticipated, no appreciable sewage contamination.

4. CRICKHOWELL RURAL DISTRICT; population (1901), 7,116; and BRYNMAWR URBAN DISTRICT (BRECKNOCK); population (1901), 6,831; Dr. R. J. Reece and Mr. Sandford Fawcett, M.I.C.E.

Authorities concerned: Crickhowell Rural District Council; Brynmawr Urban District Council.

Ground of Inquiry: Allegation by the Crickhowell Rural District Council that the defective condition of the Brynmawr sewage disposal works is responsible for the pollution of the water supplies to certain of the houses in the parish of Llanelly, which are situate north of the Clydach Brook, with the result that there has been a number of cases of typhoid fever in the said houses.

Chief Facts reported by Inspectors: The Brynmawr Urban District Council Sewage Farm is in the Llanelly Division (population, 3,077) of the Crickhowell Rural District; the outfall sewer from the Brynmawr Urban District traverses 2½ miles, partly in the Rural District of Crickhowell, before reaching the farm, where the sewage has been disposed of since 1869. The sewage disposal works at Brynmawr require alteration; they are dirty and neglected. The gradient of the outfall sewer is such as probably will not discharge six times the dry weather flow. There is need of storm filters. The sewer leaks in places, and the farm is badly managed, and irrigation not properly effected. As the sewer traverses the Llanelly Division of the Crickhowell Rural District, the pipes are carried roughly along the 1,000-foot contour line. The ground slopes steeply from the pipes to the Clydach Brook. Many houses in the villages of Clydach, Cheltenham, and Black Rock, and as well certain springs, are situate between the sewer pipes and the brook. There can be no doubt that when the sewage pipes leak they are liable to contaminate the springs, which are situate at a lower level; but the majority of these springs are also liable to be polluted from offensive privies, filthy pigstyes, and manured gardens. There is one Inspector of Nuisances for the whole of the Crickhowell Rural District, who is also Surveyor of Highways and Surveyor of Main Roads. The Board's Inspectors have in former years pointed out that the district is too large for one Inspector of Nuisances to do efficient work if his time is entrenched upon by other duties. Infectious disease

inefficiently dealt with. No isolation hospital, no disinfecting apparatus. Since 1870 deaths from "fever" have been registered each year in the Llanelly Division. Excessive incidence on the Llanelly Division as compared with the rest of the Rural District. In 1901, up to date of inspection, 72 per cent. of typhoid cases occurred in houses situate along the line of, and on lower ground than, the Brynmawr Urban District Council's sewer. Since 1849 the district has been visited ten times by the Inspectors of the Central Health Authority, and, although advice has been given on each occasion, but little progress has been made in the directions recommended. Precautions should be taken to render the Brynmawr sewer free from leakage, and a public supply of water to the villages in question should be provided from a source free from contamination, and the villages should be properly drained and sewered.

5. Darwen (Lancaster); population (1901), 38,211; Dr. Wheaton.

Authority concerned: Darwen Town Council.

Ground of Inquiry: Prevalence of diphtheria; request of the Town Council.

Chief Facts reported by Inspector: Town almost free from diphtheria previous to 1900. The epidemic of diphtheria commenced in September, 1900; preceded by scarlet fever epidemic in previous year and by prevalence of sore throat in the spring and summer of 1900. 186 cases of diphtheria in 1900, 159 in 1901 up to October 3rd. The sore throat which preceded the outbreak probably in part unrecognised diphtheria. School attendance without marked influence on prevalence of the disease. Extension of the disease facilitated by the more or less general prevalence of sore throat in the town, associated with unwholesome conditions of dwellings, prevalence of nuisances in the neighbourhood of dwellings, and defective sewerage of the town; also by the absence of hospital accommodation for cases of diphtheria.

Hospital accommodation provided but not used for diphtheria; disinfecting apparatus provided. Water supply satisfactory; sewerage unsatisfactory. Excrement disposal by pail privies—a cause of much nuisance; privy contents thrown into the sewers; house drainage often defective. Public scavenging of pail privies and removal of refuse.

6. Ditcham Park Estate (Hants); Dr. L. W. Darra Mair.

Authority concerned: Catherington and Petersfield Rural District Councils.

Ground of Inquiry: Outbreak of throat illness in and near Ditcham Park. Complaint by occupier.

Chief Facts reported by Inspector: Outbreak of illness following return home of a child from Portsmouth Isolation Hospital after an attack of scarlatina. Divisible into two series: one a series of cases of scarlatina with usual rash, not spread by school, affecting houses near but outside Ditcham Park; the other a series of cases of sore throat illness without rash—two of them fatal—affecting exclusively in the first instance children attending a school within the park. Locally it was suggested that all the cases were scarlatina; but it seemed more in accordance with the facts and experience that the second series were cases of diphtheria. Inquiry showed that the child from the Portsmouth hospital had, shortly before discharge, suffered from swelling of the cervical glands, and that several scarlatina convalescents had developed diphtheria while in that hospital. Other suggestion was to the effect that the child on her return from Portsmouth retained the infection of diphtheria as well as that of scarlatina, and may thus have started both series of cases.

Deficient hospital accommodation in the district. Unsatisfactory arrangements for disinfection of infected clothing and bedding in Portsmouth.

7. *FALMOUTH (CORNWALL); population (1901), 11,773; Dr. Buchanan.

Authority concerned: Falmouth Town Council.

Ground of Inquiry: To ascertain action taken to remedy insanitary conditions reported by Dr. Buchanan after local inspection in 1899. Inadequate information supplied by Town Council and Medical Officer of Health.

Chief Facts reported by Inspector: Improvement since 1899 in paving common yards; dealing with houses unfit for habitation; supplying flushing cisterns to water-closets; securing observance of new regulations as to dairies, cowsheds, and milkshops. Further work required, however, in certain of these matters.

House-to-house survey begun 1899 and since continued, with satisfactory results as regards house drainage, &c. Sewage disposal scheme adopted in 1901, but details not finally settled. New code of byelaws for streets and buildings proposed.

Public service of Falmouth Waterworks Company still open to many serious objections noted in 1899. Some old mains relaid; filtration area increased; supply remains intermittent, and opportunities of insuction still afforded.

New Medical Officer of Health recently appointed. Now two Inspectors of Nuisances, whose work satisfactory.

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Abstract of Medical Inspections.

8. *FISHGUARD AND GOODWICK (PEMBROKE); population (1901), Fishguard, 1,992, and Goodwick (parish of Llanwnda), 1,110; Dr. Wheaton.

Authority concerned: Haverfordwest Rural District Council.

Ground of Inquiry: Prevalence of diphtheria.

Chief Facts reported by Inspector: Diphtheria broke out at Fishguard early in 1899 among scholars of the National Schools; from thence spread to Goodwick in Llanwnda parish; has since continued to prevail in both places. It had been noted for a year or more previous to the outbreak that "sore throat" was prevalent among scholars at the National Schools at Fishguard; on examination the drainage of the schools found to be very defective; drains broken and blocked.

No hospital provision; no disinfection of clothing or of dwellings. Nuisances very rife in both places. Sewerage of Fishguard defective; at Goodwick absent. Excrement disposal at Fishguard by means of pail privies; at Goodwick by pail privies, midden privies, and w.c.'s. No scavenging of privies or ashpits at either place. Water obtained from dip wells, wells, springs, and spouts, often exposed to contamination. Sanitary administration very inefficient.

9. *FOLKESTONE URBAN DISTRICT (KENT); population (1901), 30,209; Dr. Theodore Thomson.

Authority concerned: Folkestone Urban District Council.

Ground of Inquiry: Recurrent prevalences of enteric fever.

Chief Facts reported by Inspector: For many years prior to 1896 death rate from enteric fever in Folkestone much below that of England and Wales; during 1896–1900 the death rate from this cause in Folkestone much in excess of that in England and Wales. This excess due in part to infection conveyed by milk; in part to other conditions, including fouling of the soil by leaky drains and sewers.

Many defective sewers and drains; public water supply apparently free from risk of dangerous pollution. In the older parts of the town houses often in bad condition. Open space in rear of buildings frequently insufficient. Ultimate disposal of house refuse unsatisfactory.

10. GILDERSOME URBAN (YORK, WEST RIDING); population (1901), 3,075; Dr. W. W. E. Fletcher.

Authority concerned: Gildersome Urban District Council.

Ground of Inquiry: Firstly, doubt on the part of the Board as to the efficiency of sanitary administration, and as to the sanitary condition of the district. Secondly, an outbreak of enteric fever.

Chief Facts reported by Inspector: Sanitary circumstances: Water supply from the water mains of the Morley Corporation. Drainage and sewerage: House drains generally disconnected from sewers. New and general sewerage scheme in course of construction; scheme sanctioned by the Board. Excrement disposal by means of privy-ashpits and privy-middens. No public scavenging. The district forms part of the Oakwell joint hospital district, but there is not yet any hospital.

Enteric fever: Comparative freedom from the disease for many (20) years, then, during 1899, 12 cases; during 1900, 13 cases, of which 10 occurred during October, November, and December; and during 1901, up to June 21st, 31 cases, of which 25 occurred during an "epidemic period" extending from February 24th to April 18th, no less than 20 cases being notified in March. Of the 31 cases six proved fatal. The outbreak appeared to have been due to contaminated milk supply. The second house notified as invaded during the epidemic period was that of X, a milk-seller. Three children of his were attacked. Of 18 invaded houses, 16 were supplied with milk from X's cows.

11. Holsworthy Urban District (Devon); population (1901), 1,371; Dr. Theodore Thomson.

Authority concerned: Holsworthy Urban District Council.

Ground of Inquiry: Sanitary circumstances and administration.

Chief Facts reported by Inspector: Overcrowding of buildings on area; older cottages in bad condition; courts and yards commonly ill-paved. Disposal of refuse and excrement unsatisfactory. Defective conditions of sewerage and drainage; sewage seriously pollutes neighbouring streams. Water supply liable to grave pollution, and insufficient for the needs of the district. No hospital for infectious diseases, nor any disinfecting apparatus.

12. Lancaster Rural District (Lancaster); population (1891), 8,802; Dr. F. St. George Mivart.

Authority concerned: Lancaster Rural District Council.

Ground of Inquiry: Annual reports of Medical Officer of Health repeatedly drawing attention to defective water supply of Cockerham and Thurnham; also defective sewage. A complaint of Medical Officer of Health that the difficulties put in his way prevented carrying out duties.

Chief Facts reported by Inspector: An agricultural district, chiefly concerned with cattle farming and dairy work. Water supplies generally extremely unsatisfactory. Large

portion of district dependent on stored rain-water, or on precarious supply from streams, canals, ditches, or ponds.

Sewerage of villages generally defective. Many sewers badly laid, and costing considerable sums annually for repairs. The Galgate sewer very bad. A dangerous nuisance at outfall.

Excrement and refuse disposal unsatisfactory. Many uncemented cesspits and in the porous limestone. Large cesspits often overflowing on ground near water supplies. Scavenging insufficient. No register of slaughter-houses, and no byelaws concerning them. Very unsatisfactory conditions found in these places. No registration of dairies, and the regulations (framed in 1898) a dead letter. Cubic space in cow-houses as little as 250 feet per head or less. Shippons dark and unventilated. Dairies highly unsatisfactory; numerous filth nuisances associated with them.

General sanitary administration feeble. Officers given no support by Council, and not generally consulted. Private and interested parties allowed to interfere.

No infectious diseases hospital. An agreement with Lancaster Corporation for use of their hospital on payment. No disinfecting apparatus. An impression generally prevalent that Rural District Council adverse from taking any steps to have public water supplies laid on, although Cockerham could be supplied at small cost. Urgent need of examination of all water supplies, and vigorous effort to secure public water service for Thurnham and Cockerham townships.

13. Llandilo Fawr Rural District (Carmarthen); population (1901), 21,760; Dr. Wheaton.

Authority concerned: Llandilo Fawr Rural District Council.

Ground of Inquiry: Reports of Medical Officer of Health; complaints as to outbreaks of infectious illness in the district from the Llandebie School Board.

Chief Facts reported by Inspector: Diphtheria and enteric fever persistent in the district for many years; scarlet fever recently very prevalent. Measures for preventing the spread of infectious illness almost nil.

No hospital provision; no disinfecting apparatus; dwellings seldom disinfected after infectious illness. Water supply good in Brynamman and Cwmamman, elsewhere as a rule very unsatisfactory and often very scanty. No sewers in the district; several populous mining villages greatly needing sewerage. Nuisances from watercourses containing sewage very marked. No proper house drainage, a few cesspools and catch-pits only. Excrement disposal by midden privies or pail

privies very unsatisfactory; no public scavenging. Nuisances from accumulations of refuse and from keeping of animals rife. Slaughter-houses not registered or regulated; their condition extremely unsatisfactory. Cowsheds not registered or regulated. Sanitary administration very inadequate.

14. LUDGERSHALL (WILTS); population (1901), 576; Dr. Wheaton.

Authority concerned: Pewsey Rural District Council.

Ground of Inquiry: Complaints as to the sanitary condition of the village reports of the Medical Officer of Health.

Chief Facts reported by Inspector: For many years the village has been a decaying one. In 1891 it had a population of 476 only, but since 1898, owing to War Office operations on Salisbury Plain, the population has increased. The condition of the older dwellings very unsatisfactory from dilapidation and neglect. A considerable number of dwellings now building. Water supply from wells, liable to pollution from surface washings and percolation through the upper layers of the soil; unsatisfactory results shown on analysis of the water furnished by them. No sewers in the village, liquid refuse flowing to surface channels in the streets. No house drains, liquid refuse being thrown on the ground around dwellings. Excrement disposal effected by cesspit privies and by pail privies, the latter recently introduced. Many cesspit privies now in course of removal; substitution of pail privies. No scavenging; no collection of house refuse. The District Council have no building byelaws.

15. LYDD BOROUGH (KENT); population (1901), 2,615; Dr. W. W. E. Fletcher.

Authority concerned: Lydd Town Council.

Ground of Inquiry: Want of definite information as to the sanitary circumstances of the town, and as to action taken by the Town Council on recommendations made by one of the Board's Inspectors some years previously.

Chief Facts reported by Inspector: Water supply: No public service. There are eight public pumps (six over wells on "The Ripe," from which much of the town supply is derived, the water being distributed by cartage) and many private wells, some in very questionable positions. All the wells are shallow. There is no public sewerage system. Houses are drained to very numerous cesspools, which allow of free percolation into the gravel. Excrement disposal is usually by means of privies with cesspits. No public scavenging. There is not any isolation hospital (for the town as distinct from the military

camp), but a Thresh's disinfector has been provided. Of eight recommendations made by Dr. Bruce Low, after an inspection of the town in 1894, only one, that with reference to the adoption of byelaws as to new streets and buildings and nuisances, has been acted upon. His other recommendations still hold good. The sanitary circumstances of the town and the administration of the Town Council are very unsatisfactory.

16. MILTON RURAL DISTRICT (KENT); population (1901), 12,123; Dr. R. Deane Sweeting.

Authority concerned: Milton Rural District Council.

Ground of Inquiry: Continued prevalence of diphtheria and enteric fever.

Chief Facts reported by Inspector: Six parishes chiefly affected by diphtheria, which in some instances was associated with school assemblage; some cases imported, others spread by personal infection; multiple cases in families associated with overcrowding; recurrence in families ascribed to inadequate disinfection, and associated with chronic tonsillar enlargements; some attacks due to "return" cases from hospital.

Three parishes chiefly affected by enteric fever, which was spread by personal infection, aided by absence of proper disinfection. Recurrence in families associated with improper disposal of excreta.

Back yards badly paved; many wells liable to pollution; privies badly constructed; no public scavenging; no byelaws, except for hop-picking; dairies, cowsheds, and milkshops badly supervised; no proper disinfection of houses or of infected articles.

School-closure for diphtheria not sufficiently resorted to.

17. MILTON-NEXT-SITTINGBOURNE URBAN DISTRICT (KENT); population (1901), 7,056; Dr. R. Deane Sweeting.

Authority concerned: Milton-next-Sittingbourne Urban District Council.

Ground of Inquiry: Continued prevalence of diphtheria and enteric fever.

Chief Facts reported by Inspector: Diphtheria associated with school assemblage; intermediate cases of sore throat and "colds," a few diphtheria attacks due to "return cases" from hospital. Recurrence in houses in insanitary localities. Enteric fever largely associated with insanitary local conditions, and propagated by personal infection. Recurrence in households to be ascribed to inadequate disinfection. Several attacks among screeners of London refuse and among eaters of oysters and cockles.

Much old dilapidated property in the district; back yards badly paved; many foul hand-flushed closets; sewers inadequately flushed; byelaws in need of revision; no proper disinfection of dwellings or of infected articles; cowsheds badly supervised.

School-closure for diphtheria intelligently resorted to.

18. New Romney Borough (Kent); population (1901), 1,327; Dr. W. W. E. Fletcher.

Authority concerned: New Romney Town Council.

Ground of Inquiry: Absence of definite information as to the sanitary circumstances of the town.

Chief Facts reported by Inspector: Water supply: No public water service. Littlestone-on-Sea, a part of the borough, supplied by private waterworks. Elsewhere water obtained from shallow wells sunk all about the town, usually in undesirable positions, and often close to cesspools, privy cesspits, and other sources of pollution. Littlestone provided with private sewerage system having outfall on the Hoy, where the sewage is disposed of, nominally, by irrigation. No public sewerage in the district. House drains almost invariably discharge into cesspools sunk in the porous gravel underlying the town. Excrement disposal usually by means of privies with cesspits sunk into the gravel, but there exist many closets of the hopper type, mostly hand-flushed, and discharging into cesspools, so as to cause pollution of the underlying gravel, from which the water supply is drawn. No public scavenging. There is an iron isolation hospital comprising two wards, each measuring about 30 feet by 21 feet.

The town of New Romney is in a grossly insanitary condition.

19. Prestwich Urban District (Lancaster); population (1901), 12,839; Dr. Theodore Thomson.

Authority concerned: Prestwich Urban District Council.

Ground of Inquiry: Prevalence of diphtheria.

Chief Facts reported by Inspector: In 1900, 76 cases of diphtheria, in the first half of 1901 64 cases of diphtheria, in the district. Dissemination of the disease aided by schools. Employment of school-closure, with a view to checking spread of the disease insufficiently resorted to by the local authority. Many badly-paved courts and yards. Disposal of excrement and refuse by privy-middens, which are offensive; their contents disposed of on a tip, complained of as an offensive nuisance. Sewers have inadequate fall at some points, leading to backing-up of sewage.

20. Romney Marsh Rural District (Kent); population (1901), 2,563; Dr. W. W. E. Fletcher.

Authority concerned: Romney Marsh Rural District Council.

Ground of Inquiry: Dissatisfaction on the part of the Board at refusal of the District Council to appoint only one Medical Officer of Health for the whole district; inadequacy of remuneration of the two Medical Officers of Health; doubt as to the general sanitary condition of the district.

Chief Facts reported by Inspector: No public water service. Water supply almost entirely from surface wells; some liable to pollution. Much difficulty in obtaining good supplies. Some wells brackish. Excepting at Dymchurch, no public sewerage system. The Dymchurch sewerage unsatisfactory. House drainage throughout the district defective; where provided, generally to cesspools, sometimes to ditches. Excrement disposal at Dymchurch mostly by hand-flushed hopper-closets. A few similar closets, pail-closets, and earth-closets in other parts of the district, but privy-cesspits in the majority. No public scavenging. There is an iron isolation hospital, nominally for 12 beds in two wards. Sanitary work has been almost entirely neglected in the district.

21. St. Helens Urban District (Isle of Wight); population (1891), 4,469; Dr. Bulstrode.

Authority concerned: St. Helens Urban District Council.

Ground of Inquiry: Complaints as to sanitary administration, and as to an absence of proper control of infectious disease in the village of St. Helens.

Chief Facts reported by Inspector: Water supply of St. Helens from shallow wells imperfectly protected against surface pollution. Sewerage in several portions of the district defective. Water-closets frequently unprovided with flushing apparatus. Byelaws and regulations often not properly enforced. Officers' report-books not kept. No isolation accommodation and no disinfecting apparatus and hence adequate control of infectious disease impracticable. The absence of these essentials was brought prominently home to the District Council during a recent outbreak of scarlet fever in the village of St. Helens.

22. Sittingbourne Urban District (Kent); population (1901), 8,944; Dr. R. Deane Sweeting.

Authority concerned: Sittingbourne Urban District Council.

Ground of Inquiry: Continued prevalence of diphtheria and enteric fever.

Chief Facts reported by Inspector: Diphtheria associated with school assemblage and preceded by sore throat; multiple attacks in families associated with overcrowding. Some referable to hospital "return cases." Enteric fever largely propagated by personal infection, and recurrence of the disease due to inadequate disinfection. Several sufferers engaged in screening London refuse; others, workers about Milton Creek.

No proper sewerage, but this about to be effected. Closets mostly hand-flushed and foul. Refuse "tip" complained of; but destructor about to be provided. Back yards badly paved. Byelaws in need of revision. No proper disinfection of dwellings or of infected articles, School-closure for diphtheria intelligently resorted to.

23. SPALDING RURAL DISTRICT (LINCOLN, HOLLAND); population (1901), 12,393; Dr. W. W. E. Fletcher.

Authority concerned: Spalding Rural District Council.

Ground of Inquiry: District Council's unwillingness to reduce the number of Medical Officers of Health, of whom there are four, notwithstanding the Board's representations. The district had previously been visited and inspected on several occasions, and unfavourably reported upon.

Chief Facts reported by Inspector: Water supply: Generally from surface wells, and from large brick-built underground rain-tanks, but sometimes from rain-tubs, and in many instances from the numerous dykes. The water supply is by no means satisfactory. No public sewerage. Many houses are provided with drains, mostly of faulty construction, discharging generally into "dry wells" (*i.e.*, cesspools with pervious walls), but often into watercourses, ditches, or ponds. Excrement disposal usually by means of privies with vaults, occasionally by water-closets or by pail closets. Excremental nuisances abound in all parts of the district. Many nuisances due to improper keeping of animals, both cows and pigs, especially in the case of the latter, which are also fed in a most uncleanly manner. No isolation hospital, and no disinfecting apparatus. No regulations have been made under the Dairies, Cowsheds, and Milkshops Orders. Inspection of the district reveals neglect of sanitary work and the need of proper supervision by a competent and active Medical Officer of Health.

24. STROOD RURAL DISTRICT (KENT); population (1901), 14,354; Dr. Wheaton.

Authority concerned: Strood Rural District Council.

Ground of Inquiry: Outbreaks of infectious disease—diphtheria at Halling and Frindsbury; enteric fever at

Wainscot. Unsatisfactory water supply of places in district. Complaint of want of sewerage at Halling.

Chief Facts reported by Inspector: From time to time there have been outbreaks of diphtheria and enteric fever in the district. Scarlet fever also prevalent. Enteric fever has diminished in prevalence during recent years in association with improvement of water supplies; but diphtheria has increased in association with fouling of the soil and air around dwellings from leaking cesspools, foul privy cesspits, defective house drainage, and absence of public scavenging.

Water supply at Cobham very unsatisfactory and scanty; unsatisfactory at Tong, Chalk, and Shorne. No sewers in the district, cesspools chiefly employed for disposal of liquid refuse, frequently leaking into the soil. Excrement disposal, chiefly effected by cesspit privies allowing of percolation of their contents into the soil, a frequent cause of nuisance. Great difficulties met with in the scavenging of these privies and the disposal of their contents.

Hospital provision by arrangement with the Gravesend Corporation, not satisfactory in its working. No disinfecting apparatus. Slaughter-houses not registered or regulated.

25. *WEYMOUTH AND MELCOMBE REGIS BOROUGH (DORSET); population (1901); 19,785; Dr. R. Deane Sweeting.

Authority concerned: Weymouth Corporation.

Ground of Inquiry: Prevalence of scarlatina; complaints as to maladministration.

Chief Facts reported by Inspector: Scarlatina of low mortality, mostly in autumn of 1900, affecting the better class portion of the borough, and probably imported from a neighbouring village. Hospital isolation unduly pressed by the Medical Officer of Health and magistrates' orders threatened; in some cases dismissal of domestic servants insisted upon. Hospital and ambulance arrangements extremely unsatisfactory. Disinfection of houses and belongings perfunctorily carried out.

Many insanitary courts and dilapidated dwellings in older parts, ineffectively dealt with by the Corporation. Building byelaws not properly enforced. Sewage passed directly and indirectly into the harbour at times of heavy rainfall. Outfall sewer about to be extended and placed in deeper water to prevent such pollution of the harbour. Inadequate flushing and ventilation of sewers. Many water closets unprovided with flushing cisterns. Scavenging by contractors badly performed. New series of byelaws required. Dairies, Cowsheds, and Milkshops Order of 1885 not properly enforced.

26 *Whitehaven Borough (Cumberland); population (1901), 19,325; Dr. Bulstrode.

Authority concerned: Whitehaven Town Council.

Ground of Inquiry: Prevalence of enteric fever.

Chief Facts reported by Inspector: Outbreak of enteric fever confined, for the most part, to an insanitary area of the town. Seventy-seven cases notified, with eleven deaths. Disease spread mainly by means of unrecognised and mild cases. No evidence to connect outbreak with water supply or with food. Disease presented considerable infectivity.

Much overcrowding of houses upon area, and closet accommodation often unsatisfactory and insufficient. House drainage frequently defective. Common lodging houses, slaughter-houses, and cowsheds unsatisfactory. Byelaws not properly enforced. No adequate action under Housing of Working Classes Acts, albeit housing altogether deplorable.

No. 11.

APP. A. No 11.

On Scarlatina at Weymouth and on the General Sanitary Circumstances and Administration of the Borough; by Dr. Sweeting.

REPORT on the GENERAL SANITARY CIRCUMSTANCES and ADMINISTRATION of the BOROUGH of WEYMOUTH and MELCOMBE REGIS, and on Recent Prevalence there of SCARLATINA; by DR. R. DEANE SWEETING.

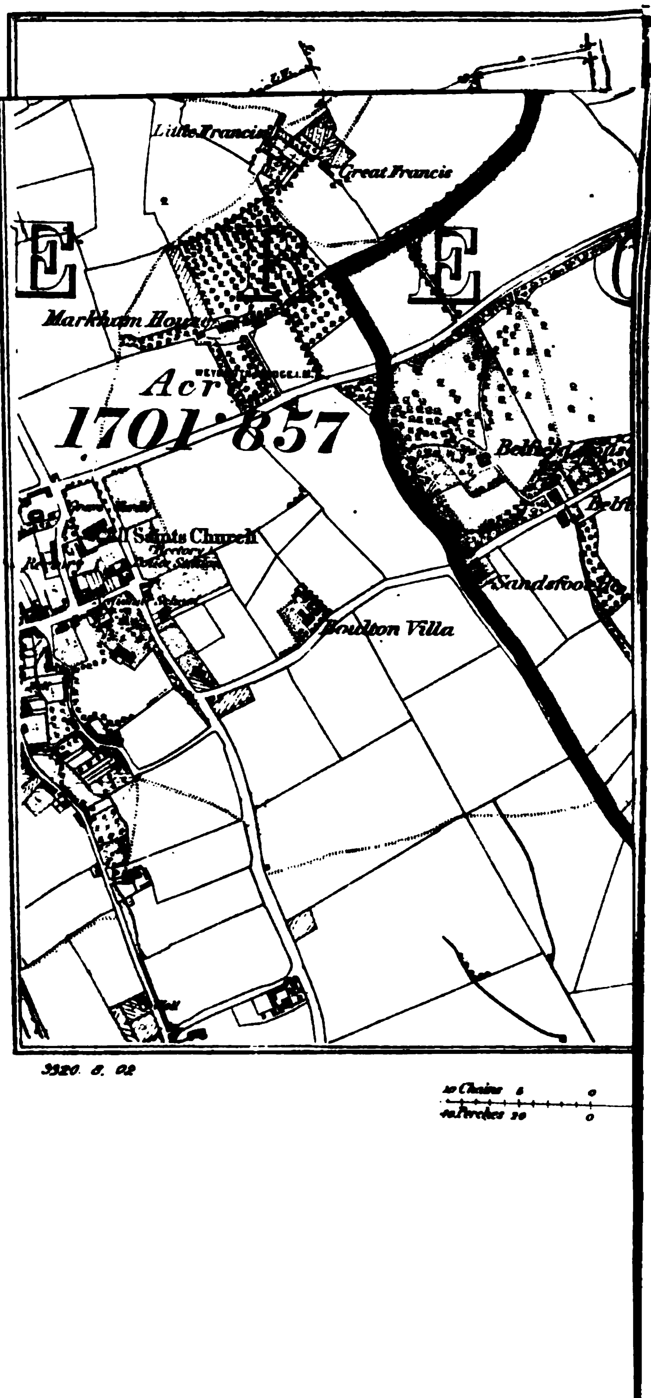
The Borough of Weymouth and Melcombe Regis, situated on Weymouth Bay in the Southern part of Dorset, was incorporated by Royal Charter in 1804 and was extended in 1895.

Before extension at the latter date, it consisted of the parishes of Weymouth and Melcombe Regis and part of the parishes of Wyke Regis and Radipole. In 1895, other portions of the two latter parishes were added from the Weymouth Rural District. The added portion of Wyke Regis parish now forms the Wyke Regis ward at the South-West, the former intra-municipal portion of that parish being added to Weymbuth ward in the South-East, south of the harbour. The portion of Radipole parish within the borough forms, along with the part of Melcome Regis parish north of the railway station, Melcombe Regis North Ward; the remaining part of that parish north of the harbour constituting Melcombe Regis South Ward. The harbour divides Melcombe Regis South Ward from Weymouth Ward. The prolongation of the harbour west and then north forms an arm of the sea known as "The Backwater," the western bank of which forms the western boundary of Melcome Regis North Ward, and which receives the River Wey at its upper part or neck. The area of the "Backwater" is 250 acres. It is divided from the harbour proper by a masonry dam, which is provided with a gateway in its centre. The borough, as extended, exhibits a narrow irregular shape, the vertical axis being about 3 miles, and the horizontal, at its greatest width, 1¼ mile (*see* Map appended). It may be said to be bounded east by Weymouth Bay and Portland Roads, south by the neck of land uniting it with the Island of Portland, west and north by the Weymouth Rural District.

The area of the borough is 1,654 acres: the population, which was 13,866 in 1891, is now, according to the Surveyor, estimated at 22,000; the Medical Officer of Health, however, puts it at a higher figure, viz., about 28,000 at the middle of the year, this not including visitors, yeomanry, and militia. The population comprises also a variable number of soldiers, and is occasionally augmented by the Fleet. Since compiling this Report, Dr. Tatham, Superintendent of Statistics in the Registrar-General's Office, has furnished me with the preliminary (unrevised) figures of the recent Census. It appears from these that the population of the borough is only 19,785. The inhabited houses are about 4,400. The assessable value is £96,269, and the General District Rate amounts to 2*s*. 2*d*. in the £.

In character, Melcombe Regis North Ward is purely residential; Melcombe Regis South Ward has, in addition to many private

lodging-houses, to ancient courts and alleys of almost



ombe Regis North Ward is purely residential;
outh Ward has, in addition to many private

residences, the majority of the shops and business places; Weymouth Ward contains a good deal of ancient property around the harbour, but towards Rodwell on the south there are many better-class houses. Wyke Regis Ward is chiefly rural in character, except at its north-east part, west of the "Backwater," where many new streets of working class dwellings are being erected in what is known as the Westham district.

Most of the borough is very flat, especially the portion behind the esplanade facing the bay, where the elevation above Ordnance datum in some places is only 7 ft. or 8 ft. The greatest elevation, indeed, in the Melcombe Regis Wards, North and South, is 16 ft. But in the southern parts of Weymouth Ward, towards the suburb of Rodwell, the ground rises abruptly to 80 ft. and even 100 ft. above datum.

Geologically, the borough is upon Oxford Clay and Coral Rag. The former is found in both the Melcombe Regis Wards, forming also the bed of the "Backwater"; the latter is found in Weymouth and Wyke Regis Wards. The Oxford Clay in that part of Weymouth facing the bay is overlaid by a bed of sand and shingle, 8 ft. to 10 ft. in thickness. The houses facing the esplanade are built on this sand and shingle, which is said to be remarkably porous.

Two railways run into Weymouth, viz., the London and South-Western and the Great Western. In connection with the latter is an important passenger traffic with the Channel Islands. Except a few breweries and brickworks, there are no important industries in the borough, which is largely dependent for prosperity upon visitors during the summer season.

The present Report will (1) treat briefly of the chief sanitary circumstances of the borough, and then (2) deal with the recent prevalence of Scarlet Fever, with special reference to administration by the Corporation and their officers in connection with this disease.

Sanitary Circumstances.

Roads.—The length of the public roads is rather over 23 miles, and of private undedicated roads a little over 7 miles: many of the latter have been newly made under the Private Street Works Act, 1892. About £3,500 has been expended under this Act, and since 1876 nearly £10,000 under the Public Health Act, 1875. The public roads are, as a rule, kerbed and channelled, either with granite or stone. Carriage ways are made of broken granite, flint, and gravel. Footways in the centre of the borough are flagged with local stone; in the outlying parts limestone and tar paving are employed. The condition of roads and footpaths throughout the borough is, as a rule, very good, the chief exceptions being some of the private roads which have not yet been dedicated.

Dwellings.—Weymouth contains a great variety of house property, ranging from commodious private mansions, hotels, and lodging-houses, to ancient courts and alleys of almost "slum"

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description. Intermediate in character are to be found modern rows of workmen's cottages, as at Westham in Wyke Ward, where building operations have of late been very active. Many curiously constructed old-fashioned houses are grouped together irregularly about the harbour. The majority of houses are of brick. In the older parts of the town many of the roofs are in a dilapidated state. Damp walls and foundations are not uncommon, as at Burdon Buildings, and even damp floors, as at Diamond Terrace. Overcrowding occurs, but it cannot be said to be common, although there are many two-roomed cottages, and even a few having only one room for all purposes. One such example I met with in one of the courts in the older part of the town, where a bedroom of less than 1,000 cubic feet capacity was occupied by a woman and four children. There are a few "back-to-back" houses, as at East and West Row. But here and at other places the disadvantage thus arising is to some extent compensated by the amount of open space in front of each row. Absence of through ventilation of dwellings is more common, as, for instance, at Horseford and Seymour Streets. But in some few cases this deficiency is partly modified by amplitude of open space in front. Diminution of proper curtilage and huddling of houses on area is common in the older quarters of the borough. This leads to mention of the numerous insanitary courts of Weymouth, *e.g.*, Styles, Foundry, Smith's, James, and Franchise Courts. Some of these are excessively narrow: thus, Styles Court is only 4 feet wide and Quiet Place 3 feet. In some of these courts the dwellings are placed on one side only of the court, in others on both sides, and in certain instances there are, in addition, dwellings at the end of the court at right angles to the passage down its centre. The first arrangement is, however, the most common, and the dwellings in such courts are invariably obstructed as to light and air by lofty buildings or walls on the opposite side of the court. Similar obstruction obtains also, but to less extent, in the two other kinds of court property mentioned above, and, indeed, one may say, in all the courts of Weymouth to greater or less degree. The air of these courts must therefore be presumed to be almost always in a state of stagnation. Obstruction to light and air in some cases is caused by the too great proximity of outbuildings belonging to the dwelling, as at Seymour Street. The structural condition of the dwellings in the various courts at Weymouth is very bad. Many of such dwellings are extremely dilapidated, as, for instance, Rolls Court. The paving of these courts, as, indeed, of the majority of the back yards attached to cottage property in Weymouth, is very defective. So far, no bye-laws have been framed, dealing with this matter, under the Public Health Acts Amendment Act, 1890. The Medical Officer of Health has reported to the Town Council, from time to time, on the insanitary property in the borough, and as recently as December, 1899, presented a special report on the subject. The Surveyor also presented a special report on this matter in 1896. Little action has been taken on this important question beyond patching up houses which have been declared by the Medical Officer of Health unfit for habitation. The closet provision seems, however, to have been improved in regard of some of them, and water has been laid on to some of the closets that were formerly without it. The inactivity of the Town

Council in this matter may be understood from the fact that, in 1900, of 61 representations made by the Medical Officer of Health, under the Housing of the Working Classes Act, 1890, closing orders were obtained in only six cases (in none of which were penalties obtained), and in only 18 cases were steps taken to repair the houses. No demolition of house property was ordered. The above facts point at least to apathy, if not to something worse, on the part of the Town Council in dealing with this important matter.

Bye-laws for new streets and buildings, based on the Board's model series, were confirmed as recently as December, 1897. The Surveyor informs me that he finds them difficult to enforce, and that only nominal penalties have hitherto been exacted for disregard of their provisions. In particular, he finds builders very negligent in procuring from him the necessary certificate as to due completion of buildings, and to a less extent that relating to notice of intention to build. I urged, in conference with this official and the Town Clerk, the stringent application of the new bye-laws and the pressing for substantial penalties on their infraction.

Water Supply.—The extended borough is supplied by a private company, which was established by an Act of Parliament of 1855, repealing the original Act of 1797, and by an extending Act of 1897. By the 1855 Act, the area of supply included the borough of Weymouth and Melcombe Regis, extra-municipal parts of Radipole and Wyke Regis parishes, and the Parish of Preston-cum-Sutton-Poyntz. By section 4 of the 1897 Act these limits were extended so as to include Broadway and Chickerell parishes, and the part of Radipole parish formerly known as Buckland Ripers. Further, by section 19, the Weymouth Company were empowered to purchase the existing rights of the Broadway and Upwey Water Company, in order to supply the parish of Upwey. This purchase has since been effected. There are now no wells at all in the borough. The public water is obtained from one principal and several subsidiary springs issuing from the Upper Greensand below the Chalk near Sutton Poyntz village, about 3½ miles north-east of Weymouth. The daily yield of the springs varies from two million gallons in dry summer weather to eight million gallons in winter. This spring water is impounded in an open collecting reservoir, which, along with about 4 acres of the gathering ground, is enclosed by iron fencing. From this reservoir the water flows in an open channel for about half a mile to the pumping works at the village. Here are two turbines and three 16 h.p. engines, to which has lately been added a 56 h.p. engine, which is not yet in use. Water is pumped to Chorlbury, about a mile away, where there is a covered service reservoir with a capacity of about 300,000 gallons. From this reservoir the water descends by gravitation to the greater part of the borough of Weymouth, where it is distributed by draw-off taps in each house, and by a few (six or eight) stand-taps in certain courts and passages.

At Rodwell, on the outskirts of the borough, there is another covered reservoir, the capacity of which is 175,000 gallons, which also receives water pumped to it from the works at Sutton Poyntz.

It has hitherto been used chiefly, though not entirely, as a storage reservoir, but it has also been employed to serve a portion of the borough in its vicinity, and it is contemplated in future to use it entirely as a service reservoir, and for a larger portion of the borough.

There is at Wyke yet another recently completed service reservoir, which has not yet been used, having a capacity of half a million gallons; but this is intended solely for portions of the rural district, and will not serve the borough at all.

The total consumption of water in the area served by the Company is about 700,000 gallons a day, which gives about 30·4 gallons per head. The trade supply is about 11·6 gallons, comprised in the above; this includes the supply to breweries, and the Great Western Railway Company at Weymouth, and the torpedo works at Wyke. The scale of charges for domestic purposes is fixed at *2d.* per week for gross estimated rentals under £10 per annum, and £5 per annum for those above £10. There are special additional charges for baths and water-closets, and for trades, manufactures, and "other special purposes." But by section 17 of the 1897 Act the charge for one water-closet is included in the "domestic rate" within the area added by that Act. The charges by meter range from *5s.* per 1,000 gallons to £15 *10s.* per 620,000 gallons, over which limit a uniform charge of *6d.* per 1,000 gallons is made.

Appended is the most recent analysis of the Weymouth water (*see* Addendum A). The Medical Officer of Health regards the water supplied to the borough as of excellent quality and of sufficient quantity, and I heard no complaints whatever of it during my inspection.

Sewerage and House Drainage.—Modern sewerage in Weymouth dates from Sir J. Coode's system of 1873, by which, though land irrigation was primarily intended, disposal of the sewage was effected by 14 outfalls into the harbour, the principal outfall for Melcombe Regis being, except at extreme low water of spring tides, tide-locked. The length of this system was 11¾ miles. Since 1873 five applications for loans in extension of the sewage works have been made the subject of inquiries by the Board's engineering inspectors, viz.:—

(1) By the late Mr. Clerke in Feb., 1895, when £17,000 was sanctioned.

(2) „ Mr. Tulloch in Sept., 1896, when £8,000 was sanctioned.

(3) „ Col. Marsh in Jan., 1899, when £13,276 was sanctioned, £8,637 being for extension, and the rest in replacement of money lost by the failure of a local bank.

(4) „ Col. Slacke in Feb., 1900, when £7,709 was sanctioned.

(5) „ Col. Hepper in May, 1901, when £4,100 was sanctioned.

In all, therefore, £50,085 has been sanctioned by the Board. Mr. Clerke's was the original inquiry, Mr. Tulloch's was required after the extension of the borough in 1896, when a population of

8,000 was added, Col. Marsh's was for new works in the extended area and in replacement of money lost in the local bank, and Col. Slacke's was for deficiencies in the estimates. The new sewers, rather over 11 miles long, were laid under the advice of Sir F. Bramwell, and completed in 1899. The completed system consists of an intercepting sewer for Melcombe Regis, another for Weymouth, collecting tank, pumping station, and outfall sewer. These may be briefly described as follows, according to the account given me by the Borough Surveyor. The Melcombe Regis intercepting sewer, 21 ins. in diameter, begins close to the shore end of the pier, receives 15 in. and 18 in. pipes, and is carried across the harbour by a cast iron syphon 460 ft. long, which is attached to the face of the dam, except at its gateway opening where it is placed below the bed of the harbour, to the tank and pumping station. The Weymouth intercepting sewer begins, as a 21 in. pipe, east of Weymouth bridge, and, receiving 18 in. pipes, proceeds direct to the tank and pumping station, situated on the west shore of the harbour.

Each intercepting sewer, as also the subsidiary 9 in. and 12 in. sewers, are circular stoneware socketed pipes jointed in cement.

The collecting tank or well, the storage capacity of which, I am informed by the Borough Surveyor, is 300,000 gallons, is concreted at the base and sides. Half of it is uncovered; the rest being placed under the three engines, which are horizontal condensing engines of 28 average horse power each, affording a pressure of 100 lbs. to the square inch. There are three pumps attached to these engines, each capable of lifting 80,000 gallons an hour to a height of 40 feet with 30 revolutions a minute. Two pumps are used at a time, so that 160,000 gallons of sewage can be raised in an hour if required. Pumping into the outfall main is effected only during dry weather and ordinary rainfall. It is performed during ebb tide only, and twice a day; but during heavy rainfall, which increases the volume of sewage materially, the whole of the sewage is pumped direct into the harbour by a so-called "storm overflow pipe" of cast iron, 18 ins. in diameter. The Surveyor tells me that this is to prevent flooding of the Park district, in Melcombe Regis ward behind the esplanade, some of which is, I understand, only 18 ins. above the level of high water of ordinary spring tides. For the same object of preventing flooding, he tells me, the sewage of the Radipole district of Melcombe Regis North ward and of Weymouth ward is occasionally shut off and allowed to pass over storm overflow weirs into the harbour. These storm overflows are seven in number, and are intended to relieve the sewers during periods of heavy rain.

From the investigation of a complaint made to me at my inspection, during which sewage was seen to have issued at a disconnection manhole, and to have flooded low-lying land adjacent, it is not altogether unlikely that, during the shutting off of sewage from Weymouth ward, this local sewer and others like it draining low-lying parts of this ward may on occasion become filled to their full capacity, and thus lead to the forcing of traps by sewer air.

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I cannot find, in the account of the four inquiries held by the Board's inspectors, any record of sanction by the Board of the use of this "storm overflow pipe" delivering into the harbour, nor of the use of the overflow weirs for other than storm water. It has evidently been found indispensable both to directly pump sewage into the harbour and to allow it to get there through the storm-water overflows.

I may mention that I received numerous complaints during my inquiry as to smells from the harbour and the "Backwater,"* and that temporary breaking down of the pumps has been acknowledged to occur. It must also be borne in mind that Weymouth is subject to sudden and almost tropical rain storms: on one occasion the rainfall was two inches in six hours.

The outfall sewer, which is said to be 17 ins. in diameter and 1¼ miles long, is of cast-iron, and passes, first, along the course of the Weymouth intercepting sewer to the beginning of this; then in a trench along the sea front; and thence along the face of the sea-wall to the end of the breakwater, 150 ft. beyond the fort at Nothe Point. Here it turns eastward and discharges into the sea, I am informed, 13 ft. below the level of low water of ordinary spring-tides. Air-valves are placed along the outfall sewer, and there is a flap-valve. The discharging capacity of this sewer is said to be 56,000 gallons an hour. The Town Council having, during the progress of their sewerage scheme and at various stages of it, given undertakings to the Admiralty and Board of Trade to extend this outfall sewer if there should be any nuisance from it, and the War Office, having required that the military bathing place between the Mixen Rocks and Nothe Fort should not be fouled by sewage, application has lately been made by the Town Council to the Board for sanction to a loan for extending this sewer 1,000 ft. to the south-east of its present termination so as to be 24 ft. below the level of low water of ordinary spring-tides. The necessary preliminary consents of the Admiralty, Office of Woods and Forests, Board of Trade, and Great Western Railway had not been all obtained at the date of my inspection, and inquiry by the Board had not been ordered.†

Two local sewers connected with the general system discharge into Portland roadstead independently viz.: (1) the "Bellfield sewer," the outfall of which is south of Sandsfoot Castle; and (2) another sewage discharging on the east of Sandsfoot Castle. Each receives the drainage of a few houses, No. 2 having been laid by the Weymouth Rural Sanitary Authority before the extension of

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* It is probable that some sewage is taken up now and again by the rising tide and deposited north of the town in the "Backwater." This undoubtedly also receives sewage from the Rural Districts by the river Wey and smaller streams, so that the complaints of odours from the "Backwater" (and also of sore throats caused by it) may not be altogether due to discharge into it of Weymouth sewage.

† These consents have now been obtained, and a loan of £4,100 has been sanctioned by the Board, after local inquiry in May, 1901, by Colonel Hepper. As the outfall sewer has been considerably extended, and its outlet is placed in deeper water, it may be expected that, with more continuous pumping, the storm overflow pipe and weirs may no longer be regarded as necessary for the discharge of sewage into the harbour.

the borough. No. 1, in addition, drains the cowsheds and stables at Bellfield farm. The Admiralty have required the discontinuance of these sewers within five years from April 10th, 1899, and this discontinuance was made a condition of the Board's sanction to loan after Colonel Marsh's inquiry in January, 1899.

The sewerage system of collecting drains, intercepting sewers, and outfall sewer is shown on the map annexed to this report.

Brewery and other trade refuse now passes directly into the harbour.

Flushing of the sewers is accomplished manually by means of hose at the manholes, sea water being generally employed. No automatic flushing apparatus has been placed on any part of the system. Bearing in mind the frequent complaints by residents of noxious smells at the open grids during hot summer weather, the Town Council should consider carefully the propriety of adding flushing tanks at the heads of some at least of the sewers. The Surveyor is not in favour of these, and there are, I understand, difficulties as to gradient, especially in the Park District. But, nevertheless, the matter is one worthy of careful consideration at the hands of the Town Council and their expert officers.

Ventilation of the sewers is carried out chiefly by road surface ventilators, of which there are in all 279 in the borough. There are only 46 upcast shafts, which are, as a rule, 4-in. cast-iron pipes, carried up the sides of adjacent buildings. On an average there is one ventilator to every 124 yards, or about 14 to the mile. The Surveyor does not encourage the latter form of ventilation, but is entirely in favour of ventilation at road level. Here, again, the question of increasing the upcast ventilation should be considered by the Town Council and their officers, as well as the sufficiency of the existing system of ventilation.

Since the completion of the sewerage system in 1899, as sketched above, all house connections with the sewers have, where possible, I am informed, been secured. The exceptions are a few outlying farms and cottages where such connection is physically impossible, and where sewage is allowed to percolate into ditches and watercourses. House-drains are generally 4-in. and 6-in. stoneware pipes. There are a few open brick gutters in old parts of the borough. Disconnection of house-drains from the sewer is now actively carried out under the new bye-laws, and many disconnection chambers have been recently put in, and traps provided with fresh-air inlets. But, at property erected before these came into force, and, generally, in the more ancient quarters of the borough, disconnection is absent. Thus, I found many sink-wastes and rain-water pipes discharging directly into house-drains, and these in turn directly into sewers. Similarly, ventilation of house-drains, though now actively progressing under the new bye-laws, is absent in a large proportion (the Surveyor estimates it at one-third) of the older property. Even at many houses of good description, *e.g.*, Abbotsbury Road, and in houses facing the Esplanade, the soil pipe ventilators are of inadequate bore, and twisted about at angles so as to greatly interfere with their efficiency.

[illegible] *Excrement and refuse disposal.*—Weymouth is a closet town, there being, it is said, no privies remaining. Most of the closets are inside the houses. But a large proportion of the closets are unprovided with flushing cisterns. The exact number at present is not known; but, from the evidence of the Surveyor and of the Water Company's secretary before the Parliamentary Committee in [illegible], in which [illegible] and 2,2[illegible]7 respectively were given as the number of premises provided with water to their closets, and estimating the present number of houses as 4,400, it is evident that the proportion of houses unprovided with means for flushing the closets must still be large. In spite of this, the pans, belonging mostly to the short hopper pattern of closet, cannot be said, in general, to be filthy; in fact, I met with comparatively few that could be so described. Where cisterns are provided, these usually hold two gallons of water. I found many closets in undesirable positions, *e.g.*, close on the street (Quiet Place), and at the foot of staircases in tenemented buildings (Burdon's). All new houses have water laid on to their closets, and opportunity is taken from time to time to insist on a supply to closets of old houses. Some of the old courts have recently been thus dealt with.

Very few ashpits or dustbins exist in the borough, pails and tubs of portable kind being in vogue. Generally, galvanised receptacles of iron or zinc are provided. Dust and refuse are collected by contractors, of whom there are two, each having two sub-districts and employing, respectively, six and five scavengers. One contractor receives £710, the other £382 10*s.* per annum. The Corporation provides the carts, which are not covered. There have been numerous formal complaints to the Town Council of the want of regularity of scavenging, and I heard many such during my inspection. Still more did I hear complaints of the condition of the tipping place at Two Mile Copse, just outside the limits of the borough, where I found a lane leading to the old tip (now disused) full of offensive decomposing animal and vegetable matter. The other three tips are at Chickerell, a few miles away in the rural district, and are not subject to the same criticism, though one of them is too near the main road, which becomes at times strewn with offensive matters blown from the tip.

In addition to overflowing ash pails, I saw a good deal of refuse littered about in some parts of the town, and also foul ditches and ponds which seemingly were receptacles for organic refuse (*e.g.*, at Rock Terrace, Myrtle Cottages, Dennis' piggeries).

The question of scavenging has engaged the attention of the Street Committee, who have quite recently (March 14th) presented a report to the Town Council, advocating a refuse destructor in a central position. This recommendation has not yet been fully considered. I heard, informally, that some of the Council were in favour of utilising the power obtainable from a destructor for electric lighting purposes; but this has apparently not yet been proposed in the Council. It was apparent to me at my inspection that there was great room for improvement in the method of scavenging, and that it would be preferable that this should be undertaken by the Town Council; and that two at least of the existing tips were not free from serious nuisance.

Slaughterhouses.—The bye-laws regulating these, based on the Public Health Act, 1848, were drawn up in 1852, and are therefore of an antiquated kind. No proper register of slaughterhouses is kept, and the list given to me by the Inspector of Nuisances was, I am led to believe, incomplete. I saw ten of them; four were dirty, four badly-paved, and only one had a blood-hole within it. Moreover, two drained to tank-cesspools, which appeared to have their overflow to the harbour, though the Surveyor asserted that all direct drainage from slaughterhouses to the harbour is now cut off.

The question of provision of a public *abattoir* has not yet been considered by the Town Council.

Common Lodginghouses.—These are not registered, and the bye-laws regulating them (drawn up in 1851) are obsolete, and, moreover, are not enforced. A list of three was given to me, but one I found to be a public-house, and under the control of the police. The other two are under the same tenant, and are dirty, badly-paved, and have no water laid on to their closets. Further, in only a few of the rooms was the usual minimum cubic space of 300 cubic feet per head afforded.

Dairies, Cowsheds, and Milkshops.—Regulations under the Order of 1885 were approved in July, 1899, but are not enforced as carefully as they should be. The official register is not kept, and it is doubtful if complete registration is effected. The list given me by the Inspector of Nuisances was taken from a private book in non-official form, and was found to be incomplete in several particulars. During my inspection I came across a number of places that were not on the list that had been given to me. Speaking generally, the condition of the dairies and milkshops is on the whole satisfactory. But the cowsheds leave much to be desired. Several are without proper drainage and water supply, some are overcrowded, others dirty and badly-paved.

Bakehouses.—I visited nine of these, taken haphazard in various parts of the borough. Five of them had no water laid on to their closets. Otherwise, with the exception of one that appeared inadequately ventilated and of another that had a sink and gully inside the bakehouse, they appeared clean and in good condition.

Offensive Trades.—These are not registered and are not controlled by bye-laws. But I cannot say that the four I visited, respectively, a knacker's yard, a tripe-boiling place, a gut-spinning establishment, and a marine store, were badly kept or unnecessarily offensive.

SOME VITAL STATISTICS OF THE BOROUGH.

The following Table (A) gives certain vital statistics for the ten years 1891–1900, prepared by the Medical Officer of Health from his annual reports:—

BOROUGH OF WEYMOUTH AND MELCOMBE REGIS.

TABLE A.—*Vital Statistics for the Years* 1891–1900.

Year.	Population estimated to middle of Year.	Number of Births.	Rate per 1,000	Number of corrected Deaths at all Ages.	Rate per 1,000.	Infant Mortality per 1,000 Births.	Number of Deaths from the Principal Zymotic Diseases.							
							Small-pox.	Measles.	Scarlet Fever.	Diphtheria and Croup.	Whooping Cough.	Typhus.	Enteric and Simple Continued Fever.	Diarrhœa.
1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.
1891 ...	15,420	454	29·4	236	15·3	88	—	9	—	4	2	—	—	1
1892 ...	15,425	306	19·8	223	14·4	114	—	3	1	1	—	—	—	1
1893 ...	15,656	309	19·7	181	11·4	93·8	—	—	1	—	1	—	—	4
1894 ...	15,776	333	21·1	183	11·5	93·9	—	—	1	—	4	—	—	2
1895 ...	15,939	302	18·2	178	11·1	109	—	1	—	—	—	—	—	12
1896* ...	27,000	494	18·9	220	8·1	101	—	9	—	1	—	—	—	6
1897 ...	27,315	462	16·9	211	7·7	112	—	—	—	1	1	—	—	9
1898 ...	27,372	476	17·4	265	9·6	120	—	—	1	1	—	—	—	6
1899 ...	27,725	481	17·3	323	11·6	138	—	3	—	1	1	—	—	36
1900 ...	27,750	483	17·3	249	8·9	129	—	3	—	—	1	—	—	3
Averages	21,537·8	410	19·6	226·9	10·9	109·7	—	2·8	·4	·9	1·0	—	—	8·0

* After extension.

From this it is seen that both the birth-rate and the general death-rate have been recorded as abnormally low, especially since the extension of the borough in 1895. The latter rate has been corrected for deaths of non-residents in no less than six public institutions in the borough, viz., five hospitals and the union workhouse.

These low rates (recorded since 1895) cannot, however, be accepted as correct, as there is reason to believe that the population of the borough has been considerably over-estimated in each year since the extension in 1895. That the present population has been greatly over-estimated is patent from the figures supplied by Dr. Tatham from the recent Census, viz. :— 19,785. There are no data afforded by the Medical Officer of Health as to any abnormality in the age-constitution of the population which will account for the extremely low death-rates recorded by him, nor is any information given of the deaths of Weymouth residents in public institutions outside the borough. The fact, too, that the infant mortality has considerably increased since the extension is an additional reason why the low general death-rate should be accepted with reserve.

RECENT PREVALENCE OF SCARLATINA.

It will have been seen, from the table of vital statistics, that the mortality from scarlatina during 1891–1900 has been small, amounting to only 4 deaths during that period. The last of these deaths occurred in 1898. The number of cases notified in 1897, 1898, and 1899 was 8, 8, and 16 respectively. During the early part of 1900, a dozen cases were notified, viz., 1 in January, 5 in February, and 6 in March. No further cases were notified until July (3) and August (2), and none was notified in September. However, during the week ending October 14th there were 8 notifications of scarlatina, and 9 during the week following. Cases continued to be notified at the average rate of 3 or 4 a week until December 9th. After this, in the next four weeks the numbers were respectively 12, 18, 17, and 21. Since January 6th, 1901, and to March 11th (when my inspection concluded), cases continued to be notified at the average of about 4 a week. Altogether, from January 1st, 1900, to March 11th, 1901, there have been 162 notified cases of scarlatina in Weymouth. Only 3 have proved fatal, all of them having been certified during the two weeks ended March 11th, 1901. The above facts are embodied in the following Table :—

TABLE B, showing the notifications of scarlatina weekly from January 1st, 1900, to March 11th, 1901.

Week ending.	Notifications.	Week ending.	Notifications.
January 7	—	August 12	1
„ 14	1	„ 19	1
„ 21	—	„ 26	—
„ 28	—	September 2	—
February 4	—	„ 9	—
„ 11	4	„ 16	—
„ 18	1	„ 23	—
„ 25	—	„ 30	—
March 4	—	October 7	—
„ 11	1	„ 14	8
„ 18	4	„ 21	9
„ 25	1	„ 28	4
April 1	—	November 4	8
„ 8	—	„ 11	3
„ 15	—	„ 18	1
„ 22	—	„ 25	2
„ 29	—	December 2	3
May 6	—	„ 9	2
„ 13	—	„ 16	12
„ 20	—	„ 23	18
„ 27	—	„ 30	17
June 3	—	January 6	21
„ 10	—	„ 13	9
„ 17	—	„ 20	2
„ 24	—	„ 27	4
July 1	—	February 4	8
„ 8	—	„ 11	4
„ 15	1	„ 18	3
„ 22	2	„ 25	1
„ 29	—	March 4	4*
August 5	—	„ 11	2†

* 2 died. † 1 died.

The following Table (C) gives the age-incidence of the notified cases of scarlatina during the period January 1st, 1900, to March 11th, 1901 :—

TABLE C.

Age period.	Number of notified cases.
0–5 years.	24
5–10 „	55
10–15 „	32
15–20 „	16*
20–30 „	21*
over 30 „	14*

* One death at each of these age periods.

There were more cases (about 34 per cent. of the whole) referred to the period 5 to 10 years than to any other. But, although children under 10 formed 48 per cent. of the whole, the incidence was unusually large upon older children and adults. Some 15 of the latter were young domestic servants. But persons of all ages were attacked, ranging from 3 months to 75 years. Two of the fatal cases were parturient women, and the third was complicated with meningitis. The epidemic has been remarkably little fatal, the case mortality having been less than 2 per cent. The 162 scarlatina cases were notified as occurring in 110 houses. In 80 of the 110 houses there occurred but one case in each instance; other 82 houses had each two or more cases, as follows :—

5	families	had	5	attacks	each, or	25	cases.
3	„	„	4	„	„	12	„
5	„	„	3	„	„	15	„
15	„	„	2	„	„	30	„

The question of the relation of plurality of attack in households to sanitary administration will be discussed later under the heading of the measures taken with regard to scarlatina.

As to the part of the borough chiefly affected by the fever, the following Table shows the relative incidence on its several wards.

APP. A, No. 11.

On Scarlatina at Weymouth and on the General Sanitary Circumstances and Administration of the Borough; by Dr. Sweeting.

TABLE D.

Showing the percentage of houses invaded by scarlatina in each of the four wards of the borough during the period January 1st, 1900, to March 11th, 1901.

Name of Ward.	Estimated Number of Inhabited Houses.	Number of Houses Invaded.	Rate per cent.
Melcombe Regis North ...	1,260	69	5·4
Melcombe Regis South ...	1,100	15	1·3
Weymouth	1,240	10	0·8
Wyke Regis	800	16	2·0
Whole Borough ...	4,400	110	2·5

From this it is seen that the incidence of scarlatina on houses has been in Melcombe Regis North ward more than double that in the borough as a whole, and considerably more than that in any other ward. The ward in question consists almost entirely of better-class residential property.

The sudden outburst of scarlatina in early October, after many months of comparative quiescence, and the sudden increase of cases during the latter part of December were ascribed to the agency of milk. The facts upon which belief in milk causation of the October outburst was based were as follow:—A domestic servant was notified as suffering from scarlatina on October 10th, this being the first case since mid-August. On ascertaining the name of the vendor who had supplied the patient with milk, the Medical Officer of Health proceeded on October 11th to one of the farms from which the milk in question was derived, and found three children of the farmer, along with the village school mistress who lived at the farm, peeling after a scarlatinal attack. This farm is at Radipole, a couple of miles from Weymouth, and from it 15 gallons of milk had been sent daily to the Weymouth milk-seller (who may be called X). The sending of this milk to Weymouth was at once stopped for three weeks by the Medical Officer of Health, who in this matter acted in collaboration with his colleague of the Weymouth rural district, and the four fever cases were sent to hospital. They had been regarded as suffering from measles; no doctor had been called in, and no precautions, presumably, had been taken to prevent spread of the infection.

On the other hand there were facts which did not favour a hypothesis of milk infection. Of the eight notifications during the week ending October 14th, and which occurred in eight

distinct families, only four (including the first notified case) were supplied by X. Similarly, of nine notifications during the week ending October 21st, occurring in five distinct families, only two, belonging to two separate families, had milk from X. Thus, during the two weeks ended October 21st, of 13 invaded families only six were supplied with milk by X, the remaining seven families being supplied from five other sources. Further, the Radipole farm was only one of six farms from which milk was sent to X, and at none of the other five farms, all of which I visited, could any human or animal illness be heard of. Moreover, the Radipole farmer supplied, besides X, 11 customers—two in Weymouth and eight in Radipole. Of the two Weymouth customers, one was attacked under circumstances of direct personal infection from the Radipole farm, as will be presently explained; of the eight in Radipole only one suffered, also referable to personal infection.

Upon the whole it cannot be said to be proved that the October outburst of scarlatina in Weymouth was due to the agency of milk. As to the exacerbation at the end of December, which was freely ascribed by some, including several medical men, to X's milk, it is true that of 68 notifications during the four weeks, December 10th, 1900, to January 6th, 1901, 38 were supplied solely by X, and other two had milk from this and another source. But not only does X supply a larger number of customers as a whole than any milk-seller in the whole borough, but he is by far the largest supplier of milk in Melcombe Regis North Ward, to which his round is chiefly confined, and where the scarlatina was most abundant. The disproportionate incidence on customers of X during this period must therefore, I think, be looked upon as more apparent than real. The exacerbation of a disease already firmly established was due, in my opinion, to other causes to be mentioned later. The Medical Officer of Health evidently did not share in the common belief of the implication of X's milk during December, for he took no steps to prohibit its sale.

But, though the Radipole milk which came into X's supply may not have been proved to have been concerned in the October outburst, it is not so certain that some of the early cases in that month did not owe their illness to direct personal infection from the cases at the Radipole farm. Thus, a gardener and a domestic servant employed at Mount Pleasant were notified respectively on October 10th and 11th. Milk had been delivered to the house where they worked before their illness by one of the farm children whose hands were noticed to be peeling. Another case, notified on October 11th, frequently passed by this farm; and other two, notified on October 15th, had done so occasionally, and therefore may have come into relation with infected persons there. Thus it is possible that five of the early cases derived their infection from this Radipole farm, though not through its milk. These five cases resided in three different quarters of the town, but three of them were in the ward afterwards principally affected, viz., Melcombe Regis North.

Two of the early cases in Weymouth, notified respectively on October 11th and 13th, attended a travelling show in Weymouth

shortly before their illness; but I could not learn that they contracted their infection from other cases there, and it was denied by the mother at the Radipole farm that her children had been to this show. I found, however, that many children from Radipole village had been there, and it is possible that the above two cases might have been indirectly infected in this way.

The broad result of the foregoing appears to be that scarlatina was, in one way or another, imported into Weymouth from Radipole early in October, 1900, and that thenceforward it attacked in preference the better-class folk of Weymouth, inhabiting a particular ward, to a much larger extent than any other portion of the population.

Once established in the borough, scarlatina appears to have spread from case to case, mostly by direct personal infection. Some children appear to have infected others at private schools; but school influence *per se* could not be credited with any large share in propagating the disease. Histories were related to me of persons being found peeling in the street and in omnibuses; and there was some suspicion, not amounting, however, to definite evidence, of infection at laundries by mixture of infected with non-infected clothing. (No action in respect to section 62 of the Local Improvement Act, to be afterwards referred to, appears to have been taken.) In fact, considerable laxity appears to have prevailed, which was contributed to in no small degree by the sociable character of the neighbourhood chiefly invaded. The exacerbation of scarlatina in December was probably referable to the increased opportunities afforded for personal infection by the conditions of the Christmas gatherings. No restraint was placed upon persons from infected houses entering public vehicles and attending churches and chapels.

Measures taken regarding Scarlatina.

Excluding the stoppage of the Radipole milk for a time, which has already been referred to, the chief measures taken to check the spread of infection may be said to have been (1) disinfection, and (2) hospital isolation. Certain subsidiary measures were also instituted or approved by the Medical Officer of Health which will be referred to hereafter.

Fumigation of infected rooms was carried out by the Inspector of Nuisances by means of a Formalin lamp. Infected clothing and bedding were treated in a small Washington-Lyons' steam disinfector situated in the Corporation yard. This is said to act efficiently; but there is no proper arrangement for separating infected and disinfected articles. The disinfector in use is of a portable kind, this having been chosen in order that it might be lent to neighbouring authorities on payment; but this does not appear to have been ever done.

Hospital isolation has been made use of to a very great extent. Thus, of the 162 notifications during the period January 1st, 1900, to March 7th, 1901, no less than 116 were sent to the Weymouth

Port Sanitary Authority's Hospital at Wyke and 2 to the Dorchester Infectious Diseases Hospital, or altogether 72 per cent. The Medical Officer of Health has pressed hospital isolation very urgently, and in so doing, doubtless from the best motives, has placed himself in conflict with many of the better class people in the place, and with at least one medical practitioner. Indeed, so acute has the tension been in the latter case that it culminated in one instance in police-court proceedings, a practitioner being fined a nominal sum for technical obstruction of the Medical Officer of Health in executing a magistrate's order for compulsory removal. In another instance formal complaint was made to the Board by the practitioner concerned and much correspondence ensued thereon. Before describing the issues in the latter case, it should be mentioned that after the police-court proceedings in the first case, which occurred in February, 1900, the magistrates drew up a set of formal regulations, embodying certain notices (copies of which will be found in Addendum B). Of these notices (*a*), was to be given by the Medical Officer of Health to the medical man in charge of a case of infectious illness; (*b*), to the parent or person in charge of the patient; and (*c*), also to the person in charge of the patient, by any medical practitioner, including the Medical Officer of Health, intending to apply for the removal of a person suffering from a dangerous infectious disorder. The magistrates resolved that no order should be made, except in great emergency, unless they were satisfied that the above notices had been duly served.

The facts as to the case in regard of which complaint was made to the Board are briefly as follow:—The Medical Officer of Health received on October 30th, 1900, notification of a case of scarlatina in the person of a young girl of 10 years, a boarder at a ladies' school in Weymouth and the daughter of a medical man in a neighbouring town. On the notification form was an intimation that the case was not without proper lodging and accommodation, nor in a room occupied by more than one family. The Medical Officer of Health visited the school the next day, October 31st, soon after mid-day, and saw the case. Before leaving, however, he accidentally met the notifying practitioner, upon whom he urgently pressed removal of the patient to hospital. The practitioner in question had not, it appears, at that time received the Medical Officer of Health's notice (*a*); he avers indeed that he did not receive it until 7.55 a.m. on the following morning, November 1st. So, too, the mistress of the school did not, she says, receive notice (*b*), until the first post on November 1st, at 7.30 a.m. Meanwhile the Medical Officer of Health asserted that he duly posted these notices. The postmark on the envelope containing each notice was, however, 4.45 p.m., October 31st. As for notice (*c*), this does not appear to have been sent by the Medical Officer of Health to the schoolmistress. He says that he showed this notice to her on the occasion of his first visit, and informed her of his intention to apply for a magistrates' order. At last, having previously, after great difficulty, persuaded the father of the child to assent to his daughter's removal, and to sign an agreement or form of indemnity to the Town Council for her maintenance whilst in hospital (*see* Addendum C (2)), the Medical Officer of Health, on November 1st,

informed one of the magistrates that he had the father's consent to his daughter's removal, displayed the above-named agreement to the magistrate, obtained the order, and the girl was removed to hospital that day. Subsequently, the father wrote indignant letters to the Board, stating in effect that he had signed the above-named "consent" under duress, since the Medical Officer of Health had threatened to close the school, and he was afraid that this would ruin the schoolmistress. As a matter of fact, the pupil was the only occupant of a bedroom on the first floor, 18 by 16′ by 8′, having two large windows, an open fire-place, and a Sheringham valve ventilator. There was a carbolic sheet outside the door, and the schoolmistress and one domestic servant, who alone entered the room, washed their faces and hands in disinfectants on entering and leaving, and wore mackintoshes over their dresses, which they changed on going out of the house. The school-house was airy, and contained seven bedrooms and five sitting rooms, two of which were used for schoolrooms. There were only three other boarders at the school at this time, who occupied rooms far removed from the sick girl; and there were 26 day scholars. The schoolmistress communicated with as many of the parents of both the boarders and the day scholars as she could, and none of them objected to the girl being kept at the school during her illness. As a matter of precaution, however, she voluntarily suspended the school for ten days. She stated that the Medical Officer of Health threatened to close the school indefinitely if the girl were not removed, and she believed that he had this power. She refused to let the girl go at 8 a.m. on November 1st, when the Medical Officer of Health himself came with the ambulance. But about 1 p.m. that day, the Medical Officer of Health having in the meantime obtained the magistrates' order, she allowed her to go with her mother, who had by this time arrived on the scene.

From the recital of the above facts, it is clear that the Medical Officer of Health displayed lack of discretion in (1) setting at naught the opinion and wishes of the medical practitioner and of the father of the patient, himself a medical man; (2) in obtruding into a sick chamber in the absence of the medical attendant; (3) in threatening to close the school, which he must have known he had no power to do; (4) in his irregularity in sending the notices. It is true that these notices are non-statutory, but they were drawn up after the first conflict in February, 1900, in order to avoid future friction, and should have been loyally followed.

In his defence, the Medical Officer of Health pleaded (*a*) the impracticability of isolation at a school, and (*b*) the provisions of a Local Improvement Act. This is the Weymouth and Melcombe Regis Corporation Act, 1887 (50 & 51 Vict. c. 153). He relies upon section 57, which is defined as explanatory of section 124 of the Public Health Act, 1875, and runs thus :—

"The words 'without proper lodging or accommodation' in section 124 (removal of infected persons without proper lodging to hospital by order of Justice) of the Public Health Act, 1875, shall, for the purposes of enabling the Corporation to remove such

persons, be construed to include any person without proper lodging or accommodation, having regard to the requirements of such person *or to the danger of infection to other persons in the same house.*"

The Medical Officer of Health especially emphasises the last sentence, which I have put in italics. I consider, however, that it was a strained interpretation of this section which led him to insist upon hospital isolation in the above case; and, whilst not denying the general futility of isolation at schools (where no proper sanatorium is provided), I consider that, under the special circumstances of the above case, the girl might have been allowed to pass through her illness at the school. The Medical Officer of Health, indeed, carries preference for hospital isolation so far as to assert that proper home isolation of scarlet fever is all but impossible. The results of this belief, translated into action in the particular circumstances of Weymouth, will be referred to subsequently.

The father of the girl above-mentioned was afterwards summoned for the hire of the ambulance used in conveying his daughter to the hospital, and was pressed by the Town Council for the sum of over £12 for his daughter's nine weeks' stay in the hospital. He objected to these charges, and, whilst paying them under protest, made certain charges against the administration of the hospital, which will be considered, with others, later in this report. He could not, perhaps, rightly complain of being obliged to pay for his daughter's maintenance, seeing that he had signed the agreement. But he might conceivably have objected on the ground that the hospital was not "suitable" or "within a convenient distance" (*see* section 124 of the Public Health Act, 1875). As regards, however, the summons for hire of ambulance, the same section distinctly lays down that when compulsory removal by Justice's order is effected this must be done "at the cost of the Local Authority," and he seemingly could have successfully resisted the claim.

This leads me to speak of the ambulance arrangements. Although an ambulance is kept at the Port Sanitary Authority's Hospital at Wyke, some 3½ miles from Weymouth, it is not often used for conveyance of patients from the borough, for the reason that a harnessed horse and a coachman have to be sent to Wyke for it (*see* No. 3 of Addendum C (1)). Instead, a private covered waggonette, kept along with other vehicles at an hotel in Weymouth, is employed for the purpose, the proprietor being under contract with the Corporation to convey patients there at 7*s*. the journey. But the proprietor charges 10*s*. for persons who can apparently afford to pay, and does not scruple to press for payment, as in this instance. This so-called ambulance is supposed to be disinfected after each journey by the Inspector of Nuisances; but I am doubtful if this always takes place. Better class people and even medical men have been known to send for this vehicle directly, without seeking the intervention of the Medical Officer of Health, and even sometimes before he has had the case notified to him. Further, no nurse accompanies the patients, whose friends are allowed to go with them. Indeed, the whole of the ambulance arrangements are highly unsatisfactory and irregular.

Although the Medical Officer of Health has actually obtained magistrates' orders in only two cases, such has been his desire to get patients into hospital that he has made free use of threats to obtain them, even at houses with ample means of isolation; and where such threats have been unavailing, or as an alternative method, he has insisted in several cases upon the dismissal of domestic servants. This procedure he attempted to justify on the ground that such servants might get scarlatina if they remained in the house; but he apparently failed to consider the possibility that such servants might be incubating the disease when thus compulsorily sent to their homes. His action as regards dismissal of servants entailed considerable hardship and inconvenience on certain families where it was carried out. Some heads of households thus treated were seemingly made to understand that the Medical Officer of Health had the legal power to do this, and the provisions of the local Act were understood by some persons to give legal sanction to this unusual course of action.

An instance was also reported to me where the Medical Officer of Health is stated to have forbidden a laundress, in whose family there had been scarlatinal illness, to follow her occupation for five weeks. The Medical Officer of Health asserted that he had "quarantined" this laundress for only ten days. But, in any case, he does not seem to have had any legal power to act thus under either the general law or the Local Act: nor would it appear to have been necessary if the usual measures had been properly carried out.

In seeming contradiction of his views as to the futility of domestic isolation of infectious sickness, the Medical Officer of Health permitted and even approved of a proceeding which led to much bitter feeling locally, and was made the subject of formal complaint to the Board. This was the use of a private house, in which scarlatina had broken out, for isolation of members of three other families, who were also suffering from the disease. Altogether this house was used for isolation purposes for three months, eight cases being treated there, of which five were isolated at one and the same time. Although certain neighbours objected very strongly to this quasi-hospital in their vicinity, and even threatened to apply to the High Court for an injunction, no particular harm appears to have been done by it. It was a large and roomy detached house, and two good-sized bedrooms were used for the patients, with an attached sitting-room. There was surmise as to subsequent infection in one of the families, members of which were isolated there, by means of letters passing between this family and the hospital-house. But the evidence was not conclusive. In any case, the Medical Officer of Health had no objection to the domestic isolation of these eight cases, in a somewhat unusual way.

It now remains to speak of the hospital in which 116 cases of scarlatina were isolated, and to deal with certain charges of maladministration in regard of it. It was built in 1880, by means of a loan sanctioned by the Board, by the Weymouth Port Sanitary Authority, to which Weymouth Borough contributes seven members, Weymouth Rural District Council, two members,

Portland Urban District Council, four members, and Wareham and Purbeck Rural District Council, one member. Weymouth Borough has, therefore, a preponderating influence on the Board, and the chairman is an alderman of that borough. The hospital is pleasantly situated in Wyke village, some 3½ miles from Weymouth, on rising ground close to and overlooking Portland Roads. Its position is well adapted for port isolation purposes. It consists of (1) two pavilions, each containing two well-ventilated wards, separated by a nurse's room, and having at each end projections, comprising closet (with pails) and slop sink, cut off from the ward by cross-ventilated lobbies; (2) an observation ward; (3) laundry and disinfecting chamber; (4) mortuary and ambulance shed; (5) administrative block. Dry earth and ashes are supposed to be added to the contents of the closet pails before burial of the contents in the hospital garden. Water is laid on from the Weymouth Waterworks Company. Each ward is 34 ft. by 23 ft. by 13 ft., and should not therefore be used for more than six fever patients. The observation ward is 13 ft. by 13 ft. by 13 ft., and, therefore, suitable for one patient; so that the hospital provides accommodation for 25 patients. The laundry is small and incomplete; it has no ironing or drying room. The disinfector is Dr. Scott's hot-air stove, which is said to attain a heat of 230 degrees Fahrenheit: I heard complaints of its scorching clothing. The mortuary has one slab and a *post-mortem* table. The ambulance shed contains a covered van, which is seldom used. The administrative block has three bedrooms, a kitchen, two sitting-rooms, and an office. With the exception of the incomplete laundry, the antiquated disinfector, and the doubtfully adequate administrative block, this hospital cannot be regarded as wholly unsatisfactory for the purposes for which it was intended, viz., a port hospital. Its 25 beds would be ample to satisfy the requirements, under ordinary circumstances, of the Port Sanitary District. But it was subjected to serious and severe strain during the epidemic of scarlet fever in Weymouth Borough, and there is hardly any wonder that its administration was thus laid open to serious comment. I would here mention that it was owing to the hospital lying, as it were, idle for so long a period that, some four years ago, the idea struck the Weymouth Corporation that they might as well use the port hospital for the borough infectious cases. This has been done by arrangement with the Port Authority from time to time, a few cases being sent in every year, but never to the extent practised during 1900–1901. The following have been the scarlet fever monthly admissions from the borough during 1900 and 1901:—February, 1900, 5; March, 5; July, 3; August, 3; October, 13; November, 13; December, 43. January, 1901, 16; February, 11; March (to 7th), 4. Total, 116. During the same period 23 cases of scarlet fever were admitted to this Hospital from the Weymouth Rural District and six from the Portland Urban District. Meanwhile seven patients have been admitted from shipboard, all of them suffering from enteric fever.

I understand that the greatest pressure upon the hospital was between December 21st and 31st, 1900, when in ten days 30 patients were admitted, no less than nine in one day. The maximum number of patients in the hospital at one time was 72.

Dr. Simpson, of Weymouth, the Medical Officer of Health to the Port Sanitary Authority, is medical officer of the hospital. The resident caretaker is a former sick-bay steward of the Royal Navy; he acts as cook, and occasionally as male nurse. His wife, who has had some experience in fever nursing, acts as matron and head nurse. They receive £45 a year between them, with furnished apartments. In addition, the husband receives certain fees as "messenger" at 1*s*. a week, which is charged to patients and recovered by the local authorities. The wife is paid 7*s*. a week per head for nursing, which is charged and recovered in the same manner; but out of this she has to provide the nurses. It is not surprising, therefore, to learn that there is only one trained nurse at the hospital: the rest are amateur "helpers," obtained from outside by the matron from time to time. There was only one such at my visit, but there were stated to have been four during the height of the epidemic at the end of 1900. The other staff includes two laundrymaids, two domestic servants, and a gardener. Of these, one laundrymaid and the gardener live outside and come to and from the hospital.

The principal allegations against the administration of the hospital may be thus summarised:—

(1.) That it was greatly overcrowded during the epidemic.

(2.) That some patients had to share beds with others.

(3.) That it was under-nursed and under-staffed generally.

(4.) That some patients were required to empty bed-pans and slops and do menial work in the wards.

(5.) That the food was bad and insufficient.

(6.) That the bed linen was infrequently changed, and that a sufficiency of towels was not provided.

(7.) That some patients were discharged with vermin in their heads, and others with ringworm.

(8.) That some were discharged from the hospital whilst still peeling.

(9.) That no earth or ashes were placed in the closet pails, which were often full to overflowing.

I investigated these charges carefully, and the result was as follows, taking them *seriatim*:—

(1) and (2.) These were fully proved. Not only were there 72 patients at one time in this hospital intended for 25 persons, but I heard of 21 patients in one of the wards (intended for six beds) occupying 12 beds. Even at my visit on February 26th, two of these wards contained respectively 9 and 13 patients. And I understood that the nurses' rooms had even been used for the reception of patients, and three patients at a time placed in the small observation ward intended for one person.

(3.) Must be regarded as proved. Even when there were 72 patients in the hospital there were only six nurses employed, four of whom were altogether untrained.

The caretaker was obliged to sleep in one of the male wards, and the trained nurse in the other. (Indeed, there are no night nurses, and the trained nurse, a young woman of about 25, was, at my visit, still sleeping at night in the male ward.) The other staff, too, were quite inadequate in number, and some of them were non-resident.

(4.) Was proved. Some of the children of better class people resented being made to do these things.

(5.) Was not proved, though I think the dietary might be made a little less monotonous.

(6.) Was not proved.

(7.) Only two were known to have ringworm. There was some conflict of evidence as to vermin, and their presence on patients was strenuously denied by the matron and by the medical officer. I think there were certainly two fully proved instances of children discharged with verminous heads.

(8.) Was proved. I heard of four well-marked instances of this. (*See* later as to "Return cases.")

(9.) Must be accepted as established. In the stress of the epidemic earth or ashes were evidently forgotten.

The nett result of my investigations into these charges was therefore adverse to the administration of the hospital, which is shown to have entirely broken down during the epidemic in many important particulars, especially as to overcrowding, understaffing, improper mode of excrement disposal, and premature discharge of patients. As to this, I found that many patients had been discharged under six weeks, several at four weeks, and that "return cases" had been not uncommon. Thus I came across several well-marked and unmistakeable instances of multiple attacks in families, where the secondary attacks occurred a few days, in no case more than a week, after the return of one or more of their members from the port hospital. Some of these had come back with peeling heels, others with nasal discharges. There is, indeed, no proper method of discharge from the hospital, the only bath-rooms being under the same roof as the wards and quite close to them.

Other, perhaps minor, criticisms of the administration are the uncontrolled visiting, and permitting mothers and nurses to accompany patients and remain with them. As to the former, visiting is not restricted to the friends of those dangerously ill; the friends of any patients are allowed to stand on a chair outside the ward and converse with them through the window. As to the latter, the result was in some cases as might have been anticipated, viz., that these persons caught the disease in the hospital.

There has been a disposition on the part of the Port Sanitary Authority (through their clerk, who is also the Town Clerk of Weymouth) to throw the blame for this mal-administration (much of which cannot be denied by them) upon their medical officer,

Dr. Simpson. But they cannot thus divest themselves of responsibility, the hospital being theirs and Dr. Simpson their officer. This is shown by his periodical reports to them on different matters of administration. As evidence of the little active interest in the hospital taken by the Port Sanitary Authority, they meet only quarterly, and have never taken any steps to stop the overcrowding which they must have known to have existed. Having agreed with the Weymouth Corporation to receive their cases, they cannot now disclaim responsibility for the treatment of the town patients in the hospital.

As to the financial arrangements, the Port Authority make a fixed establishment charge of 10*s*. 6*d*. a week for each patient, 5*s*. for disinfecting apparatus, and 2*s*. 6*d*. for disinfectants. (*See* copy of agreement, Addendum C (2), which the Corporation instructs the Medical Officer of Health to get signed in every case.) The caretaker and matron get paid at the rates already mentioned, and the medical officer of the hospital receives an uniform fee of £3 3*s*. per patient. Food is charged for in separate items by the various tradesmen according to the orders sent to them by the caretaker. Orders are apparently sent to each tradesman each day for each patient, a cumbrous and laborious proceeding which, if unregulated, might lead to waste and even dishonesty. These tradesmen's bills have apparently been paid by the Port Sanitary Authority without demur or inquiry. Dr. Simpson has under consideration the introduction of a proper dietary scale and system of accounts for provisions. I may here say that I am satisfied that Dr. Simpson spent much time at the hospital, and displayed great skill and kindness in the treatment of the patients. He lives at Weymouth and visits the hospital every day. His home is also connected with it by telephone.

The accounts when made out are paid by the local authority, who in some cases recover from the patients. They range from £10 to £14 for each patient, averaging about £12. From a return made for me by the Weymouth Borough accountant, I find that for 97 patients treated at this hospital during the 32 weeks ended March 18th, 1901, £1,085 has been paid by the Corporation to the Port Sanitary Authority and not more than £45 recovered from patients' friends. Owing, indeed, in no small measure to the widespread complaints against the hospital, many parents and guardians, although they signed the agreement previously mentioned, have refused to pay, and it is doubtful whether the Corporation will see fit to sue him, in spite of the signed agreements. Many persons told me, however, that they had no idea the bills would come to so much; that they understood from the Medical Officer of Health that they were to pay only 10*s*. 6*d*. a week. Complaints like these illustrate the divided jurisdiction in hospital matters between Dr. Simpson and the Medical Officer of Health. It is probable, therefore, that considerably over £1,000 will remain as a liability of the Corporation for the maintenance of these patients. When to this is added the yearly contribution of the Corporation to the Port Sanitary Authority of some £350, the question arises whether it would not be cheaper as well as wiser for Weymouth Borough to have its own municipal hospital, controlled by its own members and staffed by its own officers.

From another point of view, too, the Port Sanitary Authority might consider what would have happened if plague, cholera, or yellow fever had appeared in their district at a time when their hospital was full of scarlatina cases from Weymouth Borough.

Sanitary Administration.

The Weymouth Corporation consists of 32 members, who meet every month. Sanitary matters are dealt with by the "Street Committee," which meets every fortnight.

Parts 2 and 3 of the Public Health Acts Amendment Act of 1890 were adopted on May 13th, 1891. The Infectious Diseases (Prevention) Act of 1890 has not been adopted. The Local Improvement Act of 1887 has already been referred to, and section 57 quoted in full. There are also other important sections. Thus, section 56 extends the provisions of section 132 of the Public Health Act, 1875, to masters and mistresses of domestic servants. During the epidemic of scarlet fever I heard that several masters had resented being called upon to pay for their servants' maintenance in hospital. This section is, however, not often enforced. Again, section 58 enables temporary accommodation to be provided during the disinfection of dwellings. But this section has been a dead letter. No "shelters" have been provided, and families have been sent to the workhouse during disinfection of their dwellings. Section 60 obliges cowkeepers to furnish lists of customers when required. Section 61 gives the Medical Officer of Health power to inspect dairies and cowsheds beyond the borough limits by Justice's order. By section 62 persons engaged in washing or mangling clothes are to furnish lists of the owners of clothes in certain cases. The want of action taken under the Housing of the Working Classes Act of 1890 has already been referred to under "Dwellings."

Regulations under the Dairies, Cowsheds, and Milkshops Order of 1885 were approved on July 13th, 1899. Their non-enforcement has already been referred to.

There are no bye-laws relating to nuisances. Bye-laws with respect to new streets and buildings were confirmed by the Local Government Board on December 22nd, 1897. The partial success which has attended their administration has been already referred to under the heading of "Dwellings." Bye-laws as to certain pleasure gardens, as to hackney carriages, and as to the sands were confirmed by the Board in 1897 and 1899 respectively. Bye-laws as to Weymouth Harbour and in pursuance of the Petroleum Acts, 1871 and 1879, were confirmed by the Board of Trade in 1887 and 1895 respectively.

The Town Clerk is Sir R. N. Howard, J.P., formerly Mayor of the borough. He is also clerk to the Weymouth Port Sanitary Authority. He receives £600 a year as Town Clerk.

The Surveyor is Mr. W. Barlow Morgan, A.M.I.C.E., who receives £400 a year and has an assistant under him at a salary of £250 a year. Mr. Morgan has other duties, in connection

with the engineering supervision of the harbour. But he has done some good work in Weymouth in sanitary affairs, not only during the various sewerage improvements that have been carried out at Weymouth, but has made several special reports to the Corporation, *e.g.*, on insanitary property and the condition of the "backwater."

The Inspector of Nuisances is Mr. J. Keeley, who was, I understand, formerly a blacksmith, and has not received any special sanitary training nor obtained any certificate. His salary is £150 a year. Mr. Keeley's work is unsatisfactory in many respects. Thus (1) he does not keep an official register of dairies, cowsheds, and milkshops, or of slaughterhouses; (2) he does not keep any journal; (3) a book of somewhat antiquated form called "Register of Complaints" has not been kept since August, 1900, and the references to the journal in this book are of course not noted; (4) a similar book, entitled "Presentment Book of Complaints," has not been kept since August, 1900; (5) there is no book recording the number and nature of the nuisance abatement notices; some copies, however, of such notices have been kept, 18 of which appear to have been served in 1898, 21 in 1899, and 20 in 1900. Of the last only four referred to general nuisances, the remainder being repairing orders under the Housing of the Working Classes Act, 1890. No notices have been served since July, 1900.

Mr. Keeley appears to attend the meetings of the Street Committee regularly and those of the Town Council when required. His time appears to be taken up in some degree in doing work in the Surveyor's department, *e.g.*, in serving notices to drain, under section 23 of the Public Health Act, 1875. He does not seem to be as much under the control of the Medical Officer of Health as he ought to be. I discovered, during my inspection, several instances of laxity in enforcing compliance with nuisance abatement and other notices issued by the Town Clerk. I met with one case where, the nuisance remaining unabated, the occupier informed me that he had been to the Town Clerk's office and had been "excused." This was denied by the Town Clerk, but illustrates the lack of proper sanitary control.

Mr. Benjamin Browning, L.R.C.P., M.R.C.S., D.P.H., is a retired Staff-Surgeon of the Royal Navy, and receives £100 a year for his services as Medical Officer of Health. He holds, in addition, the posts of Admiralty Surgeon and Agent, District Medical Officer to the Weymouth Union, and Medical Officer to the Post Office. He was formerly Medical Officer of Health to a metropolitan district, namely, to the Vestry of Rotherhithe. He does not attend the meetings of the "Street Committee" regularly, but only when he has anything to report. He presents annual reports and an occasional quarterly report. He has also made several special reports to his Committee and the Council on such matters as the condition of cowsheds, and as to houses unfit for habitation and insanitary dwellings generally. He also presented a report on the condition of the "backwater." Some of these special reports have been distinctly good, and some of his annual reports have contained useful information.

Though Mr. Browning has not kept his journal lately, nor kept up his register of notifications, it cannot be said that he is at all negligent in his duties generally, the failure to keep the above books being partly due to pressure of other duties in connection with the scarlet fever epidemic. Far from neglecting his duties, Mr. Browning would appear to have been at times over-zealous in their prosecution, and to have shown himself not so tactful as he might have been. I refer especially to two instances in which he has come into acute conflict with a medical practitioner in the borough, and, generally, to his somewhat high-handed measures with regard to visiting patients, and to his compulsory removal of scarlatinal patients to hospital, as well as the dismissal of domestic servants from infected houses. Mr. Browning's views as to the futility of domestic isolation of infectious cases are, to say the least, very pronounced. And yet he occasionally fails to act up to them, as in the case I have above described of the private house turned into a sort of hospital. Such action as Mr. Browning's, based, as it must be acknowledged to be, on zeal in the interests of his district, tends to defeat the objects of hospital isolation and to render this unpopular. If the port hospital had been perfect in its equipment and model in its administration, his action would still have been open to criticism. But the hardship of compelling people to send their children to such a badly-administered place was distinctly great and notorious. I fear that it will be a long while before the educated classes of Weymouth will recover their faith in hospital isolation, and hence the task of establishing a municipal hospital for Weymouth may be more difficult in the future.

High-handed dealing with infectious diseases tends to defeat good sanitary administration in two ways—(1) by concealment of cases both by heads of households and medical men; and (2) by delay in promptitude of notification by the latter. Both of these happened during the epidemic, and Mr. Browning complained to me of (2). Indeed, some cases of scarlatina were not notified for a week after diagnosis, and secondary cases in families were often not notified at all. Further, many notifications were made verbally, or on forms not official, and others, being sent to the Town Clerk's office, did not reach the Medical Officer of Health for a couple of days. In one case, Sunday having intervened, the patient was dead when the Medical Officer of Health received the notification. Again, some few so-called "private cases"—*i.e.*, cases in which the private medical man treating his own patient in the hospital makes his own arrangement as to charges for medical attendance in lieu of the charges made by the Port Sanitary Authority—were actually removed to hospital before the Medical Officer of Health received the notifications or knew anything about the cases. This want of co-operation between the Medical Officer of Health and private practitioners in regard to the removal of such cases is to be deplored.

Generally, it may be said that Mr. Browning's methods have not lent themselves to the cordial co-operation which should obtain between a Medical Officer of Health and the medical men of an important borough like Weymouth. And it is open to question whether, in view of the large numbers of families

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suffering plurality of attack during the epidemic, the stringent removal of patients to hospital was, in the circumstances of Weymouth, of as much value after all as the Medical Officer of Health expected it to be.

As a collateral issue, this fact of undue number of families suffering plurality of attacks raises question as to the efficacy of the fumigation and disinfection employed. Bearing in mind the Inspector of Nuisances' unsatisfactory work in other ways, his frequent deputing of this work to subordinates, which was reported to me, and the little control of him by Mr. Browning, this matter requires close watching in future. One or two people incidentally remarked to me that the fumigation appeared to be performed in a very perfunctory fashion. And it must be remembered that there is no proper separation of infected and disinfected clothing at the Corporation yard. Again, no proper disinfection appears to have been carried out in some few houses whence there had been no notification, and from which "private cases" had been removed. It is difficult to decide whether or not the Town Council were fully aware of their Medical Officer of Health's action with regard to hospital isolation of scarlatina, which I have above described. The Medical Officer of Health certainly had definite instructions to obtain the signature of parents or guardians to the agreements to pay for hospital maintenance. And these instructions I have seen. *Primâ facie*, this would look as if the Town Council were aware of what was going on. But I am not satisfied that, as a body, they had any information of the large scale on which hospital isolation was being carried out, or of the methods whereby such isolation was being secured. It is possible that, though meeting every quarter, those members of the Town Council who were also members of the Port Sanitary Authority did as matter of fact know something of the large numbers of admissions to the hospital; but that of the threats of magistrates' orders or of the alternative of dismissing domestic servants they had no knowledge.

The results of this divided responsibility *quâ* hospital between the Town Council and the Port Sanitary Authority suffice to illustrate the need for a proper municipal hospital, directly under the control of the Corporation.

As the result of my recent inspection of the borough, I would emphasise the need for the following:—

(*a*) Greater attention to the condition of the many insanitary courts, and the more vigorous dealing with them under the Housing of the Working Classes Act of 1890.

(*b*) More rigid enforcement of the building bye-laws.

(*c*) Consideration by the Town Council and their officers of the questions of flushing and ventilation of the sewers.

(*d*) More extended provision of water to closets.

(*e*) Undertaking of scavenging by the Corporation and the provision of a destructor.

(*f*) Submission of new series of bye-laws for (1) nuisances, (2) slaughter-houses, (3) common lodging-houses, (4) offensive trades, for confirmation by the Board.

(*g*) Better enforcement of the existing regulations under the Dairies, Cowsheds, and Milkshops Order of 1885.

The work of the Inspector of Nuisances requires to be considerably improved. He should be under the control of the Medical Officer of Health, and should be obliged to keep his books properly. Failing compliance with the provisions of the Board's order by this officer, the question of obtaining the services of a duly certificated and trained inspector should be seriously considered.

ADDENDUM A.

Western Counties Laboratory,
Bristol, November 13th, 1899.

Gentlemen,

I have now completed the chemical and bacterioscopic examination of samples of Weymouth water received from your manager on the 31st ult. The samples were unexceptionable as regards appearance, and yielded the following highly satisfactory results :—

Chemical Analysis—results in grains per gallon.

Saline ammonia	·0004
Albuminoid ammonia	·0009
Nitrogen as nitrates	·24
Nitrites	Absent.
Chlorine as chlorides	1·70
Oxygen absorbed in four hours at 80° F.	·015
Total dissolved solids	20·0
Temporary hardness	11·2°
Permanent hardness	4·5°
Total hardness	15·7°
Poisonous metals	Absent.

Bacterioscopic Examination.

The number of colonies cultivable in nutrient jelly was 20 per cubic cent. No germs of disease or microbe organisms indicative of sewage pollution were discoverable by appropriate methods.

These results are in every respect completely satisfactory, and place the Weymouth water amongst those of the highest degree of organic purity.

I am, Gentlemen,
Your obedient Servant,
F. Wallis Stoddart.

The Board of Directors,
Weymouth Water Company.

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ADDENDUM B.

(*a*.) FORM OF NOTICE TO BE GIVEN BY THE MEDICAL OFFICER OF HEALTH TO THE MEDICAL MAN IN CHARGE OF A CASE OF INFECTIOUS ILLNESS.

BOROUGH OF WEYMOUTH AND MELCOMBE REGIS.

*State whether child, relation, lodger, servant, or as the case may be.

WHEREAS I have been notified that A. B. ,* residing at , in the Borough of Weymouth and Melcombe Regis, is suffering from a dangerous infectious disorder, namely :

TAKE NOTICE that I intend on the day of 19 , at o'clock in the noon, to visit such house to ascertain whether such person has proper lodging or accommodation, or is lodging in a room occupied by more than one family.

I shall be pleased to meet you at the said house at the hour named.

(Signed)

Medical Officer of Health.

(*b*.) NOTICE TO BE SERVED BY MEDICAL OFFICER OF HEALTH ON THE PARENT, OR PERSON IN CHARGE OF THE PATIENT.

BOROUGH OF WEYMOUTH AND MELCOMBE REGIS.

*State whether child, relation, lodger, servant, or as the case may be.

WHEREAS I have been notified that A. B. ,* residing at , in the Borough of Weymouth and Melcombe Regis, is suffering from a dangerous infectious disorder, namely :

TAKE NOTICE that I intend on the day of 19 , at o'clock in the noon, to visit such house to ascertain whether such person has proper lodging or accommodation, or is lodging in a room occupied by more than one family.

As witness my hand this day of , 19 .

Medical Officer of Health.

(*c*.) NOTICE TO BE GIVEN BY ANY MEDICAL PRACTITIONER INTENDING TO APPLY FOR THE REMOVAL OF A PERSON SUFFERING FROM A DANGEROUS INFECTIOUS DISORDER.

BOROUGH OF WEYMOUTH AND MELCOMBE REGIS.

* Patient and person in charge of patient.

To* , of , and to* of .

WHEREAS it has been certified by me, a legally qualified Medical Practitioner, that the above-named was, on the instant, suffering from a dangerous infectious disorder, namely : , and was without proper lodging or accommodation, or lodged in a room occupied by more than one family.

TAKE NOTICE that application will be made to a Justice of the Peace, on the day of 19 , at o'clock in the noon, at ,† for an order to remove the said to the Port Sanitary Hospital, the same being a suitable hospital or place for the reception of the sick provided within a convenient distance of the Borough of Weymouth and Melcombe Regis.

If you desire to attend yourself, or by your solicitor, or to bring medical or other evidence on the hearing of this application, you must so attend with your witnesses (if any) at the time and place named.

As witness my hand this day of 19 .

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† This may be the Guildhall, the Borough Magistrates' Office, or such other suitable place as may be approved by the Borough Magistrates.

(2.) *The Magistrates resolve that no order should be made by any Magistrate, except in the case of great emergency, without such Magistrate being satisfied by the oath of some credible witness that the above notices have been duly served* under the provisions of section* 267 *of the Public Health Act*, 1875.

* Notices may be served by delivering the same to or at the residence of the persons to whom they are respectively addressed. They may also be served by post by a prepaid letter.

ADDENDUM C.

WEYMOUTH PORT SANITARY AUTHORITY.

(1.) INSTRUCTIONS FOR PATIENTS ANXIOUS TO MAKE USE OF THE PORT SANITARY HOSPITAL FOR INFECTIOUS DISEASE.

The Chairman and Members of the Weymouth Port Sanitary Authority have decided that they are willing to allow patients suffering from

Cholera, *Scarlet Fever*,
Small-pox, *Typhus* „
Diphtheria, or *Typhoid* „

to make use of the Weymouth Port Sanitary Hospital (provided that it be not already occupied by cases from shipboard) on the following terms :—

1.—The application for an order of admission to the "Hospital" must be made to the Clerk at his office, East Street, Weymouth, between the hours of 10 a.m. and 5 p.m.; and at the time of making such application must produce a statement in writing fully setting out the nature of the disease the person is suffering from whom it is wished to be admitted.

2.—That an agreement must be signed by a responsible person, undertaking to indemnify the "Weymouth Port Sanitary Authority" against any pecuniary loss, and to provide the patient with all the necessary medical attendance, nursing, and provision, both for the patient and nurses, and pay a fee not exceeding 10*s.* 6*d.* per week for each case, for the use of the ward (which shall not, however, in any case of necessity be set apart specially for one patient) and for the necessary fuel and lights.

3.—An ambulance is attached to the hospital, and can be obtained therefrom for the use of the patient, free, if a harnessed horse and coachman be sent, and it

would be desirable at the same time to inform the caretaker thereof, in order that preparations may be made for the reception of the patient.

4.—An additional fee of 7*s.* 6*d.* will be charged in each case for disinfectants and the disinfection of the wearing apparel of the patient and nurse, as also the bed and bedding, which must be disinfected before the patient or nurse leaves the hospital.

By order,

R. N. HOWARD

Clerk to the Authority.

East Street, Weymouth.

(2.) WEYMOUTH PORT SANITARY AUTHORITY.

Weymouth, 190 .

In consideration of the Weymouth Port Sanitary Authority allowing of suffering from to be removed to their Hospital, I hereby undertake to be responsible for, and to pay the costs of all necessary medical attendance, nursing, provisions, and washing, both for the patient and the nurses, and pay a fee not exceeding 10*s.* 6*d.* per week for the use of the ward, and 7*s.* 6*d.* for disinfectants, the disinfection of the wearing apparel, bed and bedding, and also charges for a messenger, not exceeding 1*s.* a week, and should the said patient die whilst in the Hospital, that on written request to the Medical Officer to the said Authority, I undertake to remove such body within such time as such Medical Officer shall appoint, and if required pay all funeral and other expenses connected with the burial of such patient.

No. 12.

REPORT on RE-INSPECTION of the BOROUGH OF FALMOUTH and on recent SANITARY ADMINISTRATION therein; by Dr. G. S. BUCHANAN.

APP. A, No. 12.

Re-inspection of Falmouth with reference to recent Sanitary Administration; by Dr. Buchanan.

The Borough of Falmouth, it will be remembered, suffered in the autumn of 1899 from a serious epidemic of enteric fever. After local inquiry I reported to the Board, in December of that year, on the circumstances associated with the epidemic, upon sundry unwholesome conditions which were then obtaining in the Borough, and upon shortcomings of local sanitary administration. *This report was communicated to the Town Council, and on several subsequent occasions the Board has urged that authority to adopt prompt measures to remedy conditions which on all hands were admitted to be objectionable or dangerous from the view-point of public health. While replies received from the Town Council, and reports by their Medical Officer of Health, suggested that progress was being made in certain directions, the Board found that the information which they were able to obtain in this way was hardly adequate, and accordingly they decided in September, 1901, that I should revisit Falmouth in order to ascertain the present position of affairs there in regard of sanitary improvement. Although I had completed this inspection in October, I have been obliged, to my regret, to postpone reporting in view of other and more pressing duties.

It will be convenient to take in order the subjects dealt with under headings in my 1899 report.

Population, &c.—The population of the borough enumerated in 1901 was (according to the preliminary census returns) 11,773, a figure less by 442 than the population of the same area in 1891, as estimated from the census of that year. The decrease, however, is attributable to the fact that the population afloat in Falmouth Harbour at the census of 1891 was 1,168, as against 317 in 1901. The shore population is reckoned to have increasd by 409 during the ten years in question. In the same period the number of inhabited houses has increased from 1,950 to 2,159. The assessable value for the general district rate is now £39,470. The latter rate (for the parts of the town known respectively as the "Old Borough" and "Falmouth Parish") last year was the same as it had been in 1899, namely, 3s. in the £. The balance of outstanding loans in September last was £11,775, and sanction to borrow additional £1,747 was then being sought.

Streets, Dwellings, and House Accommodation.—Since 1899 one private street, Belmont Road, has been put into good order, and has been taken over as a highway by the Town Council under the Private Street Works Act, 1892, but elsewhere no noteworthy improvement has been effected in the conditions of the roadways belonging to private streets in the borough. The Town Council has caused further lengths of footway to be flagged in the last

* See "Report on Enteric Fever in the Borough of Falmouth"; Twenty-ninth Report of Local Government Board Supplement, containing Report of the Medical Officer for 1899-1900, page 181, &c.

two years, and has effected a small street improvement at Market Strand. A few of the common yards in the older courts and alleys of the town have been flagged and drained, the expense, in some instances, being shared by the Town Council with the owner. Where this has been done (*e.g.*, at Oliver Court) the conspicuous improvement which has resulted should encourage the Town Council to further work in this direction. As regards newly erected dwellings, I was informed that care had lately been taken to ensure observance of the code of byelaws which is at present in force in the borough, and that more effective control over the construction of new dwellings was anticipated in the future, as a new code, based upon the Board's model, had just been transmitted for the Board's approval. This series included byelaws made under the Public Health Acts Amendment Act. Of the numerous dilapidated dwellings in Falmouth one has been repaired as a result of the Town Council obtaining a closing order. About a dozen others in the neighbourhood of Swanpool Street, which were beyond repair, were shut up in 1900 by the owner in consequence of representations by the Town Council. Attention to other houses of similar character in certain of the older parts of the town (houses in Smithwick Hill, Allen's Yard, and at the back of the fish market, for example) appears needed. In cases where a house has been closed and is judged unfit for repair, the Town Council would find advantage in securing its demolition more speedily than has hitherto been the case. Action has been taken in several instances to obtain provision of eaves-gutters and down-spouting, and to secure paving of yards of private dwellings. To this I propose to revert when describing the sanitary survey made in connection with questions of house drainage.

Sewerage.—A few short lengths of new sewers have been provided to serve recently constructed streets. In two streets (Wellington Terrace and Vernon Place) defective portions of old sewers have been renewed. Often in making new connections of a house drain with the sewer the joint or joints of the latter which were exposed were noticed to be leaky, and have been patched up. Otherwise the sewers throughout the borough, which I described as generally showing leakage on account of the clay having worked out of the sockets of the pipes, remain in the same condition as before.

Twenty-five tall ventilating shafts have been erected at various parts of the town; most of these have been placed at high points at dead ends of sewers, but a few are at low levels. A large number of downspouts from houses which formerly were in direct connection with, and acted as ventilators to, the sewers, have now been cut off at the foot and discharged their contents over trapped gullies.

At one or two places the drainage of road channels have been diverted from the sewers to old stone watercourses leading straight to the harbour. Three flushing chambers have been placed at high points on certain sewers. A water van for flushing has also been provided.

Sewage disposal, at the date of my visit, was being effected precisely as in 1899. The Market Strand sewage tank continued

to leak, and the state of the whole foreshore of the harbour at low tide was as objectionable as ever. It was satisfactory to find, however, that the necessity of an adequate scheme of sewage disposal had at length become generally recognized in Falmouth. During the past two years the Town Council have repeatedly discussed the matter, and in one or another way have had before them a very large number of schemes, some of which included provision for a roadway skirting the harbour, and others, reconstruction of sewers in the town. At the date of my visit, with the assistance of the present Town Clerk, Mr. Armitage, I studied the many resolutions on the subject which the Town Council had adopted at various dates, and several of the reports and schemes by engineers which at different times had found some degree of favour. It is, however, needless to detail these matters here, as the outcome has been the adoption of a scheme for laying an iron intercepting sewer along the whole length of the harbour wall and on to an outfall off Middle Point, beyond the outer harbour. By this scheme the present sewer along the main street of the town, which runs parallel to the harbour wall, is to be reconstructed. Otherwise the scheme does not propose to deal with defective sewers in the town generally. Application for sanction to loan of £18,280 for this scheme formed the subject of enquiry by the Board's Engineering Inspector, Mr. E. A. S. Fawcett, on November 17, 1901. The Board are now in correspondence with the Town Council as to amendments which appear desirable in certain important matters of detail.

Excrement disposal.—Since 1899 attention has been given to water-closets without flushing apparatus, and as a result of notice from the Inspector of Nuisances, about 300 new flush tanks have been fixed. In several instances old closet pans have been removed and others of the "flush down" type substituted. In a few courts and older streets additional closet accommodation has been provided. Occasionally it appeared that such new closets might have been placed in more convenient positions—in one or two of them (*e.g.*, in Smithwick Hill), lighting and ventilation were bad.

House drainage.—Since 1899 the Inspectors of Nuisances have tested a majority of the house drains in Falmouth by the smoke test. The instances in which house drains were not revealed as leaky by this test were very few indeed; while serious defects, such as I described in my previous report, were found to be the rule, not the exception. At first, owing to the alarm created by the enteric fever epidemic, many householders in different parts of the town were urgent with demands that their drains should be tested; much work was done in a hurry, often in an unsatisfactory manner, by the local builders, without adequate supervision by the Sanitary Department. Later, however, the Sanitary Committee of the Town Council arranged a more satisfactory plan of procedure. Systematic survey of the town by the inspectors of nuisances, street by street and house by house, was arranged. After defects in house drains had been ascertained, the owner was required to expose them, and to provide new drains or to make good defects. Trapping of house drains, embedding drains in concrete where it was necessary that they should continue to pass beneath dwellings, substitution of satisfactory stoneware trap-

gullies for iron "dip-traps," disconnection of rainwater pipes and of sink waste pipes from house drains, and ventilation of soil pipes were specially insisted upon. At the same time opportunity was taken to require concreting or other improvements in the yards of dwellings, structural repairs to houses, provision of eave-spouting and down-spouting, and the like. An "ambulatory committee" of the Town Council did good work in this matter, conferring with owners on the spot, and co-operating with the officials concerned.

With one or two rather conspicuous exceptions, owners of house property deserve credit for the way in which they have met the often heavy demands made upon them in fulfilment of these requirements. Serious delay has seldom taken place, and nearly all the work has been done without the necessity of formal notice under the Public Health Acts.

At the date of my visit about two-thirds of the total number of inhabited dwellings in Falmouth had thus been dealt with. Among the streets still to be visited in the survey were several of a better class "residential" character. In view of the defective house drainage which I observed in some of these dwellings in 1899, it appears important that full attention should be paid to houses of this class. Here and there, in streets and courts which were recorded as having been "surveyed," I met with dwellings the insanitary condition of which had not been dealt with; somewhat frequently also (*e.g.*, houses in Smithwick Hill, New Street, Raleigh Place), I found that while the action taken in regard to house drainage had been thorough, other obvious defects, such as leaky roofs, defective spouting, and bad paving of yards, had been allowed to remain. Sometimes the particular circumstances of the property (for example where the owners had very little money) were such that small piecemeal improvements were all that could be looked for, but this excuse could not be urged in other of the cases to which I allude.

In my former report I represented the importance of the Town Council by their officers maintaining a much closer watch than before over the quality of all the works of sanitary improvement effected at their instance in and about dwellings. In 1901 I found that greater attention had been paid to these matters, and that generally local builders and plumbers now have come to learn what ought to be done. As an instance, however, of the need that this supervision should be maintained, I may note that a dwelling in Errisey Terrace, where drains were being relaid, I observed that the builder was about to connect a sink waste pipe to the house drain at a point between the trap on the latter and the sewer. In another case I noticed that a drain passing beneath the floor of a house was being covered with cement over its upper part, and left uncemented below. And the senior Inspector of Nuisances, Mr. Kelway, told me of several similar vagaries which had come to his notice.

It is now the custom to apply the smoke test in all cases when it is reported that the repairs of house drains have been completed. House drains of new buildings are now tested by the water test, both before and after they are covered over.

The work of *refuse collection and disposal*, at the date of my visit, was about to be transferred from the Town Council's scavengers to a contractor, it being arranged that collection should be made from the greater part of the town every day or every other day. It may be hoped that the working of this arrangement will receive close attention from the Town Council, and will prove satisfactory. The nuisance occasioned by blowing about of refuse from the broken boxes and other unsuitable receptacles used by householders continues.

Public Water Service of the Falmouth Waterworks Company.

Potential sources of dangerous pollution on the gathering area.—I revisited sundry places on the gathering ground of the waterworks at which, in my former report, I had indicated that opportunities of dangerous pollution existed. Risk of pollution of streams in consequence of deposit of manure on the land appeared to exist much as before—no attempt has been made to enclose any of the main or tributary streams at points where such pollution is liable to occur. Mr. Chubb, Inspector of Nuisances of the East Kerrier Rural District, informed me, however, that as far as possible he enjoined on the inhabitants of dwellings on the gathering area the need for depositing privy midden refuse away from the neighbourhood of streams.

As regards particular farms and buildings which in 1899 I had noticed as occasioning risk to the water service. I found that improvements had been effected in some instances, for example, at Argal Mill and at Rose Cottages. At Mabe School, the urinal and privies abutting on Mabe Stream had been drained to a cemented pit. But objectionable matters issuing from a leak in the wall at the back of the privies were finding their way to the stream close by. Any overflow which takes place from this cemented pit would also necessarily pass into the stream: moreover this pit is cleansed by means of a dipper and a handbarrow, a process which involves risk of contamination of the water-supply. It is obviously desirable that these privies and urinals should be removed to a position further away from the stream. The tank for slop water from cottages opposite Mabe School remained; its overflow would pass direct into the stream below.

Amendment has been effected in the drainage of the two hamlets on the gathering area to which I drew attention in my former report. At Mabe Burnthouse about half the dwellings are now served by a common drain which leads to a tank, the contents of which soak away into the soil. Although this tank is at the head of a slope leading down to the reservoir it appears sufficiently far away from the latter to make pollution of the water service very improbable. The late Medical Officer of Health of Falmouth, who had visited Mabe Burnthouse a few weeks before the date of my inspection, reported to the Town Council that it was then almost impossible for any sewage from this hamlet to get into the reservoir. This view, however, appeared to be somewhat optimistic. At the back of some dwellings, gullies through which

liquid refuse formerly passed to the small watercourse which traverses the hamlet on its way towards the reservoir had been allowed to remain, and continued to be usable (in one instance such a gully was obviously in use) notwithstanding the provision of new drains leading to the tank. At a farm yard in the hamlet a cemented catch-pit had been provided to receive the drainage of the yard, but a large portion of this drainage continued to find its way to open channels leading towards the reservoir. As has been indicated, slop water from about half the dwellings in this hamlet at the date of my visit was still passing into the small watercourse, and so was liable to be carried down to the reservoir.

At Treverva several drains have been provided which lead to a capacious "dry stone" tank. These drains receive slop water and also the soakage from certain privy middens. Four or five dwellings in this hamlet, however, are not yet served by this drainage system: in particular, one which stands at the head of the sloping meadow above Longdown stream.

All the improvements which have been effected in the gathering area since 1899 have been carried out at the instance of the East Kerrier Rural District Council: no action in this direction has been taken by the Water Company. It is true that the Company have lately engaged a man to do miscellaneous duty about the waterworks, but his work appears to be restricted to the reservoirs and to the small portion of land above them which belongs to the Company.

Filtration.—The Water Company have increased the area of sand in the bed of "Number 3" of their chain of low level reservoirs. The area of this "filter" is now 60 feet by 140 feet. The method by which filtration is effected, however, remains open to all the objections noted in my former report. It is said that two days are now allowed for scraping and remaking the surface of the "filter" at the bottom of this reservoir before it is again taken into use.

A few roughly constructed catch-pits have been placed along the course of Tregonhay stream, which, along with "filtered" water pumped from the low level reservoirs, furnishes the summer supply of the high level reservoir. Occasionally only a sluice is pulled up so as to divert from this reservoir any Tregonhay water which is considered too impure to admit to the supply. A bye-wash has been constructed to prevent Tregonhay water thus diverted from flowing down into the low level, Number 1, reservoir beneath. Arrangements are also being made by which it will be possible on occasion to pump "filtered" water from the low level reservoirs direct into the high level main, and so to permit cleansing of the high level reservoir. It can hardly be contended, however, that these works are sufficient to render the high level reservoir a satisfactory source of supply. Houses on the high level service in Falmouth continue to suffer by reason of deficiency of pressure due to the situation of this reservoir.

Distribution of water in Falmouth.—Considerable lengths of the principal low level mains in Falmouth have lately been taken up and replaced by new piping. A few of the many "dead ends"

on branch mains have been done away with. I was informed that the desirable practice of periodically washing out the "dead ends" is still neglected. No attempts appear to have been made to remedy the condition of domestic supply pipes, or to seek for points of leakage therein. As to this, I may quote from a report made by Mr. C. E. Phillips, M. Inst. C.E., in September, 1900, on the results of a careful and comprehensive survey of the water service undertaken by him at the instance of the Town Council.

"I inspected many of the services in the back yards and passages. They are most unsatisfactory, and many are close to the surface, and in all that came under my observation the lead pipes were laid in the most irregular manner, with only copper bit joints—there were no proper made plumbers' joints. At junctions of some of the pipes leakages were taking place. As an example, the service in the yard between 5 and 6 Market Strand was uncovered in my presence and showed a leakage where a branch was taken off. The service was immediately under the pavement and close to a drain. Under such conditions it is not difficult to imagine, as suggested by Dr. Buchanan, that insuction may take place with unpleasant results. There appears to be little or no control exercised over the customers' fittings, though it is essential in the Water Company's interest to prevent waste, and in the interest of the town to avoid contamination, especially in Falmouth where the water is so frequently turned off and the mains emptied."

In this connection also, clause 69 of the Falmouth Waterworks Act, 1862, may be noted :—

"The Company shall not be compellable to supply any person with water unless the apparatus and pipes provided or to be provided shall be of such material and so constructed and used as to prevent waste or undue consumption of the water of the Company and the return of foul air and noisome or impure matters into the mains or pipes belonging to or connected with the mains or pipes of the Company."

The waste of water in Falmouth continues to be great. In nearly every court and back yard visited I found water flowing more or less freely from the tap. If it were not for the deficiency in pressure, the intermissions in the supply, and the large number of persons who often depend upon a single tap for water, the present large daily consumption per head, estimated at 28 gallons, would be considerably exceeded.

Intermissions in the supply take place much as before. In the summer the high level service is shut off nearly every night, and it is still the custom to shut off both high and low level supplies on Fridays to allow repairs, connections, and disconnections to be made at any point of the town. On these occasions, as I was informed by the Company's water bailiff, rapid emptying of all the pipes on the water service is still frequently effected by running off the water into the harbour, thereby increasing the opportunities of insuction. Latterly a few stop cocks have been provided which enable a supply of certain areas to be controlled without cutting off the supply.

I heard of several recent complaints in Falmouth where the supply of individual dwellings had failed owing to obstruction of the domestic supply pipe, or of its ferule, by matters in suspension in the water. I was informed, however, that, upon the whole, blocking of pipes in this way has become less frequent, partly no doubt because of the new low level mains which have been provided, and partly owing to the filtration now practised at the

waterworks, which probably suffices to prevent any considerable quantity of decaying vegetable matter in the reservoirs from entering the supply. In 1900, when in Falmouth on other business, I had the opportunity of observing some of the old low level mains which were then being removed: their interior was almost filled with slimy peaty-looking matter.

Appearance and chemical quality of the water.—Doubtless for similar reasons, the appearance of Falmouth water also seems to have improved, their being less turbidity and yellow colour about it. There is not, however, much indication from chemical analysis of permanent difference in its quality. I append the record of a series of analyses by Mr. Kitto of samples sent to him in 1900 and in 1901 by the Town Council. It is instructive to note the considerable variations in the proportions of oxygen absorbed, of albuminoid ammonia, and of nitrates shown by samples taken at different dates.

Proposed purchase of Waterworks by Town Council.—In 1900 the Town Council obtained from Mr. Phillips a report upon the nature and cost of the various works considered necessary to render the water service satisfactory, alike in quality and in quantity, namely:—Improvements on the watershed; alterations in the low level chain of reservoirs, and construction of efficient filters and of a service reservoir; addition to pumping machinery and construction of a new high service reservoir at a higher level; relaying of mains; and overhauling domestic service pipes and fittings. Mr. Phillips also advised as to the probable cost of purchasing the waterworks undertaking, which, together with the amount needed for the more pressing works of improvement, he estimated at £74,500. In October, 1900, the Town Council adopted Mr. Phillips' recommendations, and, as in 1898, sought the sanction of ratepayers with a view to promote in Parliament a Bill for the purpose. Sanction was, however, refused by a considerable majority. Since that date the Town Council, through its Water Committee, has made representations from time to time to the manager of the waterworks respecting the conditions of the service, and has called his attention to sundry complaints made to them by persons supplied. Neither the replies to these representations, nor the action taken by the company, however, have indicated intention on the company's part to undertake the comprehensive works of improvement which are necessary to provide a water supply above suspicion as regards quality and adequate in quantity.

Regulations respecting *Dairies, Cowsheds, and Milkshops* were adopted by the Town Council in 1900. I found that in some of the cowsheds in the borough considerable improvement in lighting, ventilation, and drainage had recently been effected. In one cowshed which I visited the regulation which require milk vessels to be cleansed with steam or hot water was not observed. Two cowkeepers whom I saw ignored the regulation requiring thorough cleansing of the udder and teats of the cow, and of the hands of the milker before milking.

Isolation Hospital accommodation.—In 1900 the Town Council invited the Town Council of Penryn and the Rural District

Council of East Kerrier to join in a scheme for hospital provision. Representatives from both districts attended informal conferences at Falmouth, and a convenient site in the East Kerrier district, near Penryn, was fixed on. The Falmouth Town Council, on May 12th, 1900, petitioned the Cornwall County Council to constitute the three districts a hospital district under the Isolation Hospitals Act, 1893. The County Council then inquired by letter of the Penryn Council whether the latter was willing to join the proposed combination. The town clerk of Penryn actively opposed the project, the Penryn Town Council answered in the negative, and the East Kerrier District Council followed the lead of Penryn.

Falmouth Town Council meanwhile sought the Board's advice in view of the possibility that question would arise of directing by Order, under section 2 of the Isolation Hospitals Act, 1893, that the Act should apply to the Borough of Penryn. The Board replied, however, that the result of the County Council's inquiry should be first ascertained, The County Council, however, without instituting local inquiry, informed the Falmouth Town Council, on June 14th, 1901, that thay did not propose to move in the matter.

From the view-point of efficiency, the combination appeard to have, *primâ facie*, much to commend it, and the failure above described is to be regretted as much in the interests of Penryn and East Kerrier as of Falmouth. No independent hospital provision has since been made by Falmouth.*

No action has been taken by the Town Council to obtain a *disinfecting apparatus*, independently or in conjunction with neighbouring authorities. Such an apparatus is needed not only for the borough, but also for the purposes of the Falmouth Port Sanitary Authority.

Sanitary Administration.

Since 1899 the Town Council has shown considerably greater activity in sanitary matters than formerly was the case. As will be seen from the information given above, substantial progress can already be reported in securing amendment in the conditions of dwellings, and in certain other directions. In the matter of sewage disposal, there is at length promise of improvement being effected at an early date. There remains, however, a variety of important public health questions which call for serious and sustained effort. Recent proposals for sanitary improvement have in some instances met with considerable opposition both within and without the Town Council, but there is reason to believe that the Falmouth public are coming to realise the necessity of such improvement to the welfare, present and prospective, of the town; and it is to be hoped that they will give increased encouragement to the Town Council to perform good work in this sense, and will support necessary expenditure for the purpose.

* Since the above was written I learn that the Town Council have expended £300 in erecting a small hospital building of a temporary character close by the isolation hospital of the Falmouth Port Sanitary Authority.

App. A, No. 12.

Re-inspection of Falmouth with reference to recent Sanitary Administration; by Dr. Buchanan.

At the date of my visit the late medical officer of health, Dr. T. King Bullmore, was still in office. Dr. Bullmore had lately found the duties devolving upon him increasingly onerous, and in January of this year he resigned his appointment, in which he has been succeeded by his son. The discouragement which Dr. Bullmore had in the past received, both from the Town Council and from the sanitary authorities of the areas out of which the present borough was formed, must be held responsible in considerable measure for the difficulty which he has found in recent years in taking initiative, and in affording capable guidance to the Town Council. Mr. C. C. Bullmore, his successor, for some years has performed for his father nearly all the work of medical officer of health of the Falmouth Port Sanitary Authority, and he has used this opportunity to make study of beri-beri and other diseases met with among seamen at that port. He has now been appointed Medical Officer of Health to the Port Sanitary Authority. He is also in private practice in Falmouth. The Town Council would do well to consider whether their medical officer of health, however willing in their service, can devote the amount of time which is needed for satisfactory performance of the important duties of the office in return for the present salary of £60 per annum.

The senior inspector of nuisances, Mr. Kelway, appears to have done much careful and conscientious work since 1899. The Town Council in 1899 very properly appointed a second inspector. The present second inspector, Mr. Williams, who has the certificate of the Sanitary Institute, was appointed in the summer of 1901.

It was satisfactory to find improvement in the way in which books and records were kept at the office of the Town Council. The book recording the results of the house to house survey above alluded to, if kept to date, should be valuable for future use. The Town Council would find it advantageous to keep fuller and more exact particulars of the sewerage system of the town, and especially of sewers in new streets. The record kept of new buildings is meagre, and advantage should be taken of the adoption of new building byelaws to effect an improvement in this respect.

ADDENDUM.

RESULTS IN GRAINS PER GALLON OF ANALYSES BY MR. B. KITTO OF SAMPLES OF WATER SUPPLIED BY THE FALMOUTH WATERWORKS COMPANY.

ADDEN

APP. A, No. 12.

Re-inspection of Falmouth with reference to recent Sanitary Administration; by Dr. Buchanan.

RESULTS IN GRAINS PER GALLON OF ANALYSES BY MR. B.
WATERWORKS

—	Date of					
	27th November, 1899. 1.		15th February, 1900. 2. From Low Level Reservoirs.		11th June, 1900. 3.	
	High Level.	Low Level.	Un-filtered.	Filtered.	High Level.	Low Level.
Chlorine	2·3	2·2	2·13	2·13	1·99	2·03
Nitrogen in nitrates ...	·035	·105	·21	·175	·113	1·05
Ammonia free	·0047	·0022	·0028	·0028	·006	·0036
Ammonia albuminoid ...	·0190	·0141	·0157	·0066	·0119	·0172
Oxygen absorbed from permanganate at 82° F. in 15 minutes.	·066	·072	·0495	·0393	·044	·070
Oxygen absorbed from permanganate at 82° F. in 4 hours	·171	·220	·1432	·1369	·102	·149
Total solid matters in solution.	10·0	11·2	10·6	10·8	17·4	18·5
Solid matters reduced by ignition to	5·4	6	7·2	7·3	8·0	6·6
Poisonous metals (copper and lead).	Nil.	Trace of lead.	Absent.	Absent.	Nil.	Nil.
Hardness (degrees) ...	2·3	2	1½	1½	1¾	1¾
Appearance in column two feet deep.	Yellowish, clear.	Yellowish brown, very turbid.	Yellowish green, fairly clear.	Yellowish green, quite clear.	Yellowish, quite clear.	Yellow turbid.

PLACE OF COLLECTION

No. 1. High Level—Melville Road (Tap).
Low „ —Green Bank Hotel (Tap).

No. 2. (Reservoir samples)—
Unfiltered, from the main reservoir.
Filtered, from one of the low level reservoirs below the filter bed.

No. 3. High Level—Melville Road (Tap).
Low „ —3, Stratton Place (Tap).

No. 4. High „ —Vernon Place (Hydrant).

No. 4 samples were collected by Mr. Phillips, the

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KITTO OF SAMPLES OF WATER SUPPLIED BY THE FALMOUTH COMPANY.

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Re-inspection of Falmouth with reference to recent Sanitary Administration; by Dr. Buchanan.

Collection.

1st September, 1900. 4.		7th December, 1900. 5.		8th March, 1901. 6.		22nd June, 1901. 7.		19th September, 1901. 8.	
High Level.	Low Level.	High Level.	Low Level.	High Level.	Low Level.	High Level.	Low Level.	High Level.	Low Level.
2·09	2·09	2·03	2·13	2·0	2·0	2·3	2·2	2·4	2·5
None.	None.	·105	·105	·192	·157	·017	·017	Nil.	Nil.
·0120	·0073	·0032	·0152	·004	·0021	·0012	·0042	·0054	·0022
·0197	·0223	·0095	·0107	·0109	·0074	·0134	·0112	·0161	·0208
·0734	·1417	·0982	·0394	·0463	·0346	·036	·044	·04	·068
·1405	·2914	·197	·1297	·105	·09	·0899	·1165	·099	·156
9	10·6	9	11·1	9·6	9·3	7·6	9·2	8·4	7·6
7	6·6	6	7·5	5·2	6·1	5·2	6·9	6·2	4·8
Absent.	Absent.	Absent.	Absent.	Nil.	Nil.	Nil.	Nil.	Nil.	Nil.
1¾	1¾	2½	2·7	1½	1½	1¾	1¾	1½	1½
Brownish yellow, opaque.	Brownish yellow, opaque.	Yellow.	Yellow.	Yellow, clear.	Yellow, clear.	Yellow, clear.	Yellow, clear.	Both sa Yellow.	mples. Clear.

OF ABOVE SAMPLES.

No. 4. Low Level—Dunstanville Terrace (Hydrant).
No. 5. High „ —Park Terrace (Tap).
Low „ —Church Street (Tap).
No. 6. High Level—99, Killigrew Street (Tap).
Low „ —Bakehouse Yard (Tap).
No. 7. High „ —Linhay-Melville Road (Tap).
Low „ —Albion Hotel (Tap).
No. 8. High „ —6, Clare Terrace (Tap).
Low „ —Fish Strand Hill (Tap).

remainder by the Water Committee of the Town Council.

No. 13.

APP. A, No. 13.

On Recurrent Enteric Fever and Sanitary Administration at Folkestone; by Dr. Thomson.

REPORT on RECURRENT PREVALENCES of ENTERIC FEVER in the FOLKESTONE URBAN SANITARY DISTRICT; and on the SANITARY ADMINISTRATION of the LOCAL AUTHORITY; by Dr. THEODORE THOMSON.

In recent years Folkestone has suffered from enteric fever in a degree not only unusual in this district, which had before this been comparatively free from the disease, but at times also serious in itself. Locally, these occurrences of enteric fever have attracted a good deal of notice, and have led to the expression of different views as to their causation. Among the partisans of one or another view there are those who blame the sanitary administration of the district, and who attribute the occurrences of enteric fever to conditions arising from alleged failures of duty on the part of the Local Authority.

Under these circumstances the Board, in June, 1901, instructed me to make local investigation as to the conditions under which there had been unusual prevalence of enteric fever in Folkestone in recent years, and to inquire concerning the sanitary administration of the district. This investigation was commenced by me in June, and, after a temporary postponement, was concluded in the end of the year.

The Urban District of Folkestone, on the south coast of Kent, had, at the Census of 1901, a population of 30,209, with an area of 2,321 acres. Its rateable value is £219,000. The older part of the town lies, for the most part, on the sides and bottom of a somewhat narrow valley descending to the harbour. The newer parts of Folkestone spread fanwise along the upper part of this valley as it opens out to the north, and over the high ground to the east and west of the valley. Most of the town stands on the Folkestone Beds of the Lower Greensand, overlaid in considerable part by brick-earth or sandy loam. The eastern and north-eastern extremities of the town, however, are on the Gault, overlaid by a few feet of clayey gravel with flints; while there are also two small patches of Gault in the more central and western parts of Folkestone. In the eastern and north-eastern parts of the town situated on the Gault the subsoil water is generally within three or four feet of the surface, while in the Lower Greensand neighbourhoods its depth varies from a few feet to as much as 70 feet below the surface, according to the level of the latter above Ordnance Datum.

SANITARY CIRCUMSTANCES OF FOLKESTONE.

Streets, Courts, and Yards.—There are about 30 miles of streets in Folkestone. For the most part they are macadamised and in good condition. Courts and yards are commonly well paved and fairly clean.

Dwellings.—There is in Folkestone a large proportion of houses occupied by the well-to-do and middle classes. The houses of the poor, who are less numerous than is usual in a town of this size, are in the main of satisfactory construction and in fair condition. But to this fairly general rule there are a good many exceptions: notably in the older parts of the town, where houses which are old, defective in structure, and inadequately lighted and ventilated are not infrequently encountered. In these older neighbourhoods there are several instances of dwellings closely huddled together with insufficient air-space in front and rear. Indeed, even in the newer parts of the district there are instances of inadequate air-space in the neighbourhood of dwellings, and this even when these dwellings are of fairly good class.

Refuse and Excrement Disposal and Removal.—Folkestone is a watercloset town. The closets are generally of satisfactory pattern and furnished each with a two-gallon flushing cistern. House refuse is removed by the Local Authority from twice to six times a week, according to the size and requirements of the house. The Local Authority do not possess a destructor. The house refuse is carted to a tip, which lies about two miles from the centre of Folkestone and about three miles from the eastern parts of the town. On this tip, which is situated in the Cheriton Urban District, an enormous quantity of refuse has accumulated. When I visited the place in June it was in a very offensive condition.

Sewerage and Drainage.—Many house drains in the district have been reconstructed in the past ten years. The Inspector of Nuisances, who is also Building Inspector, estimates that about 50 per cent. of house drains in Folkestone have been dealt with in this way during this period. This officer considers that of the remainder about half are probably in fair condition and about half are probably defective. While in Folkestone I saw a considerable number of house drains that had been found to be defective and were in course of reconstruction. Disconnection of sinks and waste pipes, and ventilation of soil pipes, are properly secured in most instances. But efficient disconnection of house drains from sewers is frequently lacking.

The sewerage system of Folkestone, like the house drainage, appears to be in a stage of transition. From sewers I have myself seen exposed, and from evidence derived from lists of sewers that have been reconstructed or repaired in the past two years, old and leaky sewers, sometimes laid with insufficient fall, would appear to be not uncommon in the district. Sewer ventilation is inadequate. There are only about 70 ventilating shafts, while there is no ventilation by manholes for sewers in the district.

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Flushing of sewers is effected by emptying the contents of water-vans down manholes, save as regards two lengths of sewers fitted each with an automatic flushing tank. There are said to be several dead ends of sewers which cannot be precisely located, and which cannot be flushed. In part of the low-lying neighbourhood near the harbour cellars are liable to be flooded by sewage. The sewage of the district is discharged in a crude state into the sea near the harbour. Owing to recent extension of the harbour pier, change has been taking place in the sea currents near the sewer outfall, with the result that there has been increasing tendency to deposit of sewage matter in the harbour and on the adjacent foreshore.

Water Supply.—The water supply of Folkestone is derived from the public service of the Folkestone Water Company, save in a few instances where local wells are made use of. This company takes its water partly from the chalk, partly from the Greensand, to the north of Folkestone. There has, in the past, been occasional shortage of this supply; but since extension of the works in 1898 shortage has not occurred. Chemical analyses of this water are favourable, and there is no appearance of risk of dangerous pollution in the neighbourhood of its sources.

Slaughterhouses; Dairies and Cowsheds; Bakehouses; Common Lodging-houses.—There are six slaughterhouses; six cowsheds, and 11 dairies and milkshops; 26 bakehouses; and four common lodging-houses in the district. Slaughterhouses are generally well paved and clean; but, in most instances, drainage is conveyed to a gulley inside the building, and the lairs are in direct communication with the interior of the slaughterhouse. Cowsheds are for the most part fairly satisfactory as regards structural conditions and cubic space. Dairies, milkshops, and bakehouses are, with one or two exceptions, good. Common lodging-houses are not satisfactory. In two instances the kitchens used by the lodgers are on a sunk floor, very low roofed, and badly lighted. Two of the common lodging-houses are premises licensed to sell intoxicating liquors.

ENTERIC FEVER IN FOLKESTONE.

The history of Folkestone as regards enteric fever has been singularly favourable during the past 30 years, saving for the recent occurrences which form the subject of this report. The mean annual death-rate from enteric fever (including continued fever and the like) in Folkestone during the ten years 1871–80 was 0·19 per 1,000 of the population; in 1881–90 it was 0·10 per 1,000; in 1891–1900 it was 0·15 per 1,000.

During the first two of these decades this fever death-rate was far lower than was the corresponding rate in England and Wales as a whole; in the third decade it was again lower than the corresponding rate in England and Wales, but very little so. The following figures show the distribution of these deaths in

Folkestone over the years of the third decade; and the number of cases of enteric fever that came to the knowledge of the local authority in the same period :—

TABLE I.

Year.	Deaths from Enteric Fever.	Known Cases of Enteric Fever.
1891	2	7
1892	—	6
1893	—	5
1894	2	7
1895	—	10
1896	4	18
1897	4	40
1898	8	36
1899	16	87
1900	5	50

It appears from the death figures in the above table that material increase of enteric fever in Folkestone commenced in 1896 and continued up to 1899, and that in 1900, although there was diminution as compared with the previous year, the fever was still prevalent in serious amount. In the last half of the decade the mean annual death-rate from enteric fever was 0·26 per 1,000, a rate much in excess of that for England and Wales during the same period. The "case" figures indicate more accurately the progress of the disease in the district during 1891–1900, and give a general support to the indications afforded by the death figures.

In 1901, 14 cases of enteric fever are known to have occurred in Folkestone, while three deaths were referred to this disease. Of these 14 cases, four were visitors who had contracted the disease before their arrival in Folkestone. In this year, therefore, Folkestone may be regarded as having reverted to the condition of relative freedom from enteric fever that had characterised it for so many years anterior to 1896.

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The incidence of the fever as regards the age and the sex of persons attacked during the period 1896–1900 is shown year by year in the following table:—

TABLE II.

Year.	Under 5.	5–14.	15–24.	25–34.	35–44.	45 and upwards.	Total at all ages.	Males.	Females.
1896 ...	2	8	4	3	1	—	18	3	15
1897 ...	2	13	15	8	—	2	40	13	27
1898 ...	3	10	9	10	2	2	36	18	18
1899 ...	2	22	28	18	12	5	87	40	47
1900 ...	—	15	24	6	5	—	50	13	37

In the consideration, at a later stage, of the incidence of the fever as regards sex and age, it will have to be borne in mind that, at the 1891 census, there were in Folkestone 138 females to 100 males; whereas, at the same time, in the Urban Districts of England and Wales there were 108 females to 100 males. It must also be remembered that, up to the age of 15, there was no material difference, according to the census of 1891, between Folkestone and these urban districts, as regards the proportion of males to females; but that marked difference in this respect is manifest as regards persons aged 15 and upwards, as appears from the following figures:—

TABLE III.

Age Period.	Urban Districts in England and Wales.	Folkestone.
Under 5	100 Males to 101 Females	100 Males to 102 Females.
5 —	" " 101 "	" " 106 "
10 —	" " 102 "	" " 102 "
15 —	" " 108 "	" " 160 "
20 —	" " 116 "	" " 195 "
25 —	" " 113 "	" " 165 "
30 —	" " 108 "	" " 158 "
35 —	" " 106 "	" " 138 "
40 —	" " 109 "	" " 140 "

TABLE III.—*continued.*

Age Period.	Urban Districts in England and Wales.	Folkestone.
45 —	100 Males to 109 Females	100 Males to 140 Females.
50 —	" " 113 "	" " 146 "
55 —	" " 118 "	" " 140 "
60 —	" " 122 "	" " 164 "
65 and upwards ...	" " 138 "	" " 149 "

There is, it will be seen, an unusally large excess of females over males at ages above 15 in Folkestone, this excess being most marked at ages from 15 to 35.

It appears also from the 1891 census that the juvenile population in Folkestone is relatively smaller than in the urban districts of England and Wales. In the latter in 1891, 34·7 per cent. of the total population was under the age of 15, while in Folkestone only 31·8 per cent. of the total population was under this age.

CAUSATION OF ENTERIC FEVER IN FOLKESTONE IN RECENT YEARS.

At an early stage of my investigations it became apparent that the public water supply of Folkestone had not had concern with the undue prevalence of enteric fever there in recent years. The circumstances of the supply are not such as to cast suspicion upon it, and there had been no corresponding increase of the fever in the Urban Districts of Sandgate and Cheriton, which receive, the latter almost wholly, the former in part, the same supply as Folkestone. In Cheriton, which had at the census of 1901 a population of 7,091, only two cases of enteric fever are known to have occurred during the four years 1897-1900, viz., one case in 1897, one in 1898, and none in either 1899 or 1900.

Nor did the consideration of the other sanitary circumstances of Folkestone afford satisfactory explanation of the repeated occurrences of fever in the town. The fever was not mainly restricted to neighbourhoods characterised by markedly unhealthy conditions, but affected all parts of the district in much the same degree. Some of the dwellings in which the disease appeared were found to be defective as regards drainage, but not in marked proportion to the total number of houses invaded.* Exceptional incidence of the fever on houses along particular lines of sewers

* This proportion was highest in 1900, when rather more than one-fourth of the houses invaded by the fever were found to be seriously defective as regards drainage conditions.

was not observed. There was therefore no indication of direc relation between conditions of sewerage and drainage and incidence of the disease. Whether there may have been indirect relationship of this kind will be referred to at a later stage.

The possibility of specifically infected shell-fish having played any material part in the recent fever occurrences in Folkestone also received consideration. But satisfactory evidence as to fever due to such cause was not forthcoming, save as regards a group of six cases in 1899. These six persons had, on August 27th of that year, eaten oysters in company from the same barrow. Four were notified to the local authority as suffering from enteric fever on September 10th; another was notified in like way on September 12th; while the sixth, who had fallen ill about the same time as the others, was notified on September 30th. The oysters in question had been derived from the Medway, and bacteriological examination of oysters from the same bed, at a a later date, revealed the presence of *bacillus coli communis* both within the oysters and in the water contained in their shells. Beyond this instance, however, there is no indication that there had been relation between recent fever occurrences in Folkestone and consumption of shell-fish.

But investigation of the milk supplies of the houses invaded by enteric fever in 1896-1900 led to the conclusion that milk had from time to time during this period had a considerable share in the dissemination of this disease in Folkestone. In order that the relation of this agency to the fever may be adequately appreciated, it is necessary to consider the fever occurrences along with the milk supply in each of the five years in question. Comprehension of the facts about to be set forth in this way will be facilitated by reference to the accompanying chart, showing the distribution in time of enteric fever in Folkestone in each of these years, as indicated by notifications of the cases of the disease.

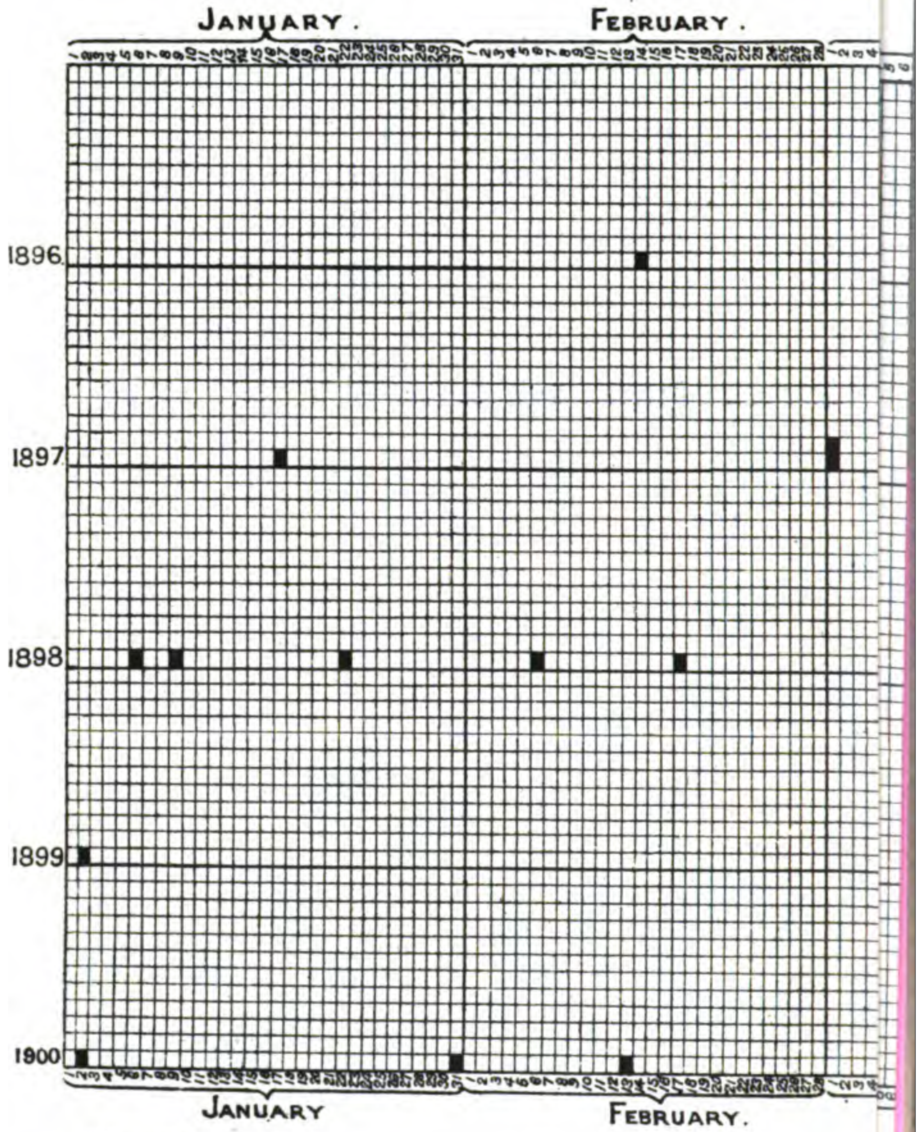
1896.

In this year 18 cases of enteric fever are known to have occurred in Folkestone. When compared with the average amount of enteric fever in towns of like size this number of cases presents nothing remarkable. But comparison with the fever records in Folkestone itself in immediately preceding years shows that in 1896 the known amount of enteric fever in Folkestone was approximately double what had for some time been usual. And examination of the diagram for 1896 shows that the distribution of the fever over the year was unusual, occurring, as it did, mainly as two small outbreaks in the months of May and December respectively. Of the 18 cases in this year, seven occurred in the first half of May and seven in the second half of December.

Of the seven cases in May, six occurred in four houses with a common milk supply; the seventh case was "imported."* The

* This term is used to indicate cases that developed, while in the district, fever that had been contracted outside the district; as shown by consideration of the date of their arrival in Folkestone, the date of onset of illness, and the length of the incubation period of enteric fever.

CHART SHOWING THE



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milk vendor who furnished this supply served rather less than 100 houses in Folkestone. A case of enteric fever in the Elham Union Cottage Homes, situated outside Folkestone, but supplied with milk by this vendor, was notified on April 11th. In February also, in Folkestone, a single case of the fever occurred in a house to which this vendor furnished part of the milk supply. At the farm from which this man procured his milk the well-water used for washing the milk cans was found to be polluted by sewage, while the drinking water for cows was obtained from tanks which received surface water from an adjacent road. There were two cottages on the farm premises, and the families occupying these cottages had both suffered with "influenza" in the month of February. In the same month a boy, working at the farm, was attacked by "influenza," but was subsequently notified to the Local Authority of the Rural District in which this farm is situated as the subject of enteric fever.

This milk was prohibited from being sold in Folkestone on May 4th. The last case that occurred in the town in relation with this milk during the year was notified to the Local Authority on May 16th.

Of the seven December cases, six occurred in five houses with a common milk supply, and were notified to the Local Authority as enteric fever between December 22nd and 29th. In this instance the milk vendor was not the same whose milk supply was implicated in May. He served about 100 houses, and procured his supply of milk from two farms. At one of these farms, when well-water ran short, use was made of water from a tank which, as in the case above described, received surface water from an adjacent road. No case of enteric fever is known to have occurred about the milk vendor's premises or at either of the two farms from which he procured milk.

Although both these outbreaks of fever were of small dimensions, the close relationship of the cases in time in each instance, and the almost entire restriction of the fever to houses furnished, and furnished solely, with milk by a particular vendor, point, in the absence of local conditions affording a sufficient explanation, to milk having been in May and December the main agent of dissemination of the disease in Folkestone.

It may be noted that of the 12 cases definitely associated with these supplies in the two months in question 10 were females. The smallness of the figures involved, however, does not permit that weight should be attached to this undue incidence on females; it is here noted merely as being consistent with the theory of infection derived through milk, since fever so conveyed is known to affect females in larger proportion than males.

1897.

In this year 40 cases of enteric fever are known to have occurred in Folkestone. As will be seen from the chart, there were seven cases scattered over the first five months of the year, followed by entire absence of the disease until September, from the latter part of which until early December there was

considerable prevalence of fever. Of these 40 cases, five were "imported," while two contracted the fever in the local hospital for infectious diseases. The remaining 33 cases occurred in 29 houses. The milk supply to these 29 houses was furnished by 19 vendors; but 13 of these houses, in which 14 cases occurred, were supplied by a particular vendor. To nine of these this vendor furnished their sole milk supply, while to four he furnished only part of their supply. This vendor was the same person on whose milk-round fever made its appearance in December, 1896. The number of his customers was, as already noted, about 100. The seven cases that occurred during the first five months of 1897 resided in seven houses, of which five were supplied with milk by this vendor in whole or in part. Two more cases occurred in a house with this milk supply in the end of September and the beginning of October. Again, between October 19th and November 29th, out of 10 known cases of fever, seven occurred in seven different houses furnished with this supply.

The long-continued and at no time heavy incidence of the fever on houses supplied by this vendor is not in accordance with the customary behaviour of infectious disease disseminated by means of milk; at the same time, the large proportion of invaded houses on this milk-round, amounting to 13 per cent., taken into consideration with the fact that implication of other milk-rounds, several of them with many more customers, was almost nominal, forbids its exculpation from share in dissemination of the disease. It is noteworthy, in this connection, that of the 14 consumers of this milk attacked by the fever 11 were female. This is a larger incidence on females than can be accounted for by the proportion of females to males in Folkestone. But again the figures are too small to justify stress being laid upon them; the utmost that may properly be said is that they are consistent with the theory of infection having been conveyed by milk.

Undue incidence of fever is also usually observed among children when milk is the agency by which it is spread; but it is doubtful whether trustworthy conclusions, based on facts as to incidence of fever in particular age groups in Folkestone, can be drawn, in view of the large proportion of females there at ages over 14.

There remain, in this year, 19 cases of enteric fever, in 16 houses, not accounted for as having been consumers of the incriminated milk supply, nor as having been "imported," nor as having contracted the disease at the local hospital for infectious diseases.

1898.

In this year 36 persons are known to have suffered from enteric fever in Folkestone. Five were notified to the Local Authority in January and February; the remaining cases were distributed over the latter half of the year. Of these 36 cases, three were infected in the local hospital for infectious diseases, three are

believed to have contracted the fever while nursing patients sick with the disease, and one was "imported." Four out of the five cases in January and February can be accounted for in one or other of these ways. The 29 cases not accounted for in any of these ways occurred in 27 houses, supplied with milk by 16 vendors. Locally, suspicion fell on two of these vendors. On the milk round of one of them six cases occurred in five houses; these cases were notified between June 27th and July 18th. Suspicion of this milk was increased by the fact that the water used in this vendor's dairy was, on analysis, pronounced contaminated with sewage. But, on the other hand, this milk vendor served no fewer than 400 houses; so that the incidence of the fever on the houses to which he furnished milk was but 1·25 per cent. And, further, as regards two of the five invaded houses, he was not the sole purveyor of milk. He was not prohibited from continuing to supply milk in Folkestone, and no further cases of the fever occurred on his milk-round in this year. The only suspicious circumstance is the fact that five of these six cases were notified within the short period of six days (June 27th—July 2nd), at a time when there were no other known cases of the fever in Folkestone.

On the round of the other milk vendor who came under suspicion, six cases also occurred in five houses, to four of which he was the sole purveyor. This vendor served 250 houses; and the cases on his milk-round were distributed over a period of four months, from the beginning of August to the end of November. The rate of incidence of the fever on the houses served by this vendor was 2 per cent. These data, unsupported by other evidence, afford no justification for the hypothesis that this particular milk supply was aiding in the spread of enteric fever in this year.

In fact, with the possible exception of the first group of cases discussed, there is no evidence that milk played any part in the dissemination of enteric fever in Folkestone in 1898. As regards incidence of the disease on sex it is to be noted, subject to the limitation already laid down regarding inferences based on small numbers, that it is consistent with milk not having had concern with propagation of the fever in this year. For, of the 29 cases under consideration, 16 were males and 14 were females; a proportion which holds good as regards cases in houses served with the suspected milks, as well as regards those in houses not so served.

1899.

In 1899, 87 cases of enteric fever, in 75 houses, are known to have occurred in Folkestone. More than four-fifths of the cases were notified in the months of September and October, the number of notifications attaining their maximum in the second week of the latter month. Subsequent to October only six cases were notified. Of the total number of cases, three were "imported" (two in September, one in October), and six were referable to oysters. These latter, which have already been dealt with, were notified in September. Of the remaining 78 cases (in 66 houses), 24 were notified in September and 39 in October

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These 66 houses were supplied with milk by 21 vendors. But there was special incidence on houses supplied by four of these milk vendors, as indicated by the following list:—

Milk Vendor.	Number of Houses served by Milk Vendor.	Number of Cases of Enteric Fever in Houses served by Vendor.	Number of Houses served by Vendor invaded by Enteric Fever.	Percentage of Houses served by Vendor invaded by Enteric Fever.
				Per cent.
A. ...	100	18	17	17
B. ...	400	22	19	4·75
C. ...	120	9	5	4·2
D. ...	250	7	6	2·4

These four vendors derived their milk, either wholly or in part, from a common source, which may conveniently be referred to as A.X., inasmuch as the source included milk from two farms, one of which belonged to the vendor A., the other to a farmer X., who did not himself retail milk in Folkestone, as did A. X. supplied from 60 to 80 gallons of milk per day; A. supplied about 12 gallons. These milks were sometimes mixed together, sometimes not. The joint supply was conveyed to Folkestone by A., who then partly supplied B., C., and D. with certain amounts, and sold the remainder on his own milk-round. The whole of the milk sold by A. on his milk-round came from the A.X. source. The proportions of this milk in the total amounts sold by B., C., and D. on their rounds were respectively about one-fifth, one-fourth, and one-fifth. The A.X. milk was also taken by yet another vendor, of whose total supply it constituted about one-eighth. This vendor served about 180 houses; and three cases of the fever, in three several houses, occurred on his milk-round. There was, therefore, approximate correspondence between the proportion of A.X. milk served on these milk-rounds and the proportional incidence of the fever on the customers of the several vendors of it. The total number of fever-invaded houses supplied in these ways with A.X. milk was 49—not 50, since one of the houses was supplied by two of the implicated vendors. In these 49 houses there were 58 cases of enteric fever. So that, out of 66 houses with 78 cases of fever, 49 houses, in which 58 cases of fever occurred, were supplied with A.X. milk. With nine exceptions, the cases in houses supplied from this source were notified in September and October. The delivery in Folkestone of that part of the A.X. milk furnished by X. was prohibited on October 12th; and after November 9th no further cases were notified in houses supplied by vendors who had been furnishing A.X. milk, while only two other cases were notified in the district after that date. It is to be observed, however, as indicated by the dates of notification of cases, that the maximum infectivity of this milk was reached about September 22nd, after which date it rapidly declined; so that decrease of the number of cases notified in the last three weeks of October is to be attributed to this

decrease in infectivity, and not to prohibition of the milk, a step which would not affect the numbers of cases reported until the end of the month. Delivery of that part of the A.X. milk furnished by A. was not prohibited, and continued to be supplied in Folkestone.

As regards incidence of the fever on sex in 1899, it will be observed from Table II. that, in view of the proportion of males to females in Folkestone, there was a slight preponderance on the former. But of the 58 cases in the houses supplied with A.X. milk, 21 were males and 37 were females—an undue incidence on the latter sex.

There is, therefore, reason for attributing to the A.X. milk the dissemination of a serious amount of enteric fever in Folkestone in 1899. With a view to determining whether it was A.'s milk or X.'s milk that was to blame for this occurrence, the following facts require consideration.

On August 10th a case of enteric fever in X.'s house was notified to the Local Authority, while a second case in the same house was similarly notified on August 22nd.* On examination, the house drains, conveying slop-drainage and water-closet drainage, were found to be defective, and were leaking in the neighbourhood of a rain-water tank, from which drinking-water was supplied to the milch cows on the farm. Of two Medical Officers of Health who inspected this tank in August, 1899, one considered that it was at one point defective and would allow percolation from the exterior into its interior. The water was analysed both chemically and bacteriologically; and, by the latter method, the presence of the *bacillus coli communis* was demonstrated in considerable amount. Conditions such as these would appear to cast suspicion on the milk from X.'s farm. But the other Medical Officer of Health who inspected this water tank could detect no defective condition that would permit of leakage into its interior; nor could I, when I examined this tank in 1901, discover such a condition, although it had undergone no repair during or since 1899. The presence of bacillus coli in a water derived from the roofs of houses and outbuildings is not in itself an indication of dangerous pollution, since these may have come from the droppings of birds, or in other ways not necessarily associated with danger to health. The apparently suspicious conditions quoted, therefore, cannot, unless supported by other evidence, be regarded as sufficing to incriminate the X. milk. And there is another fact which, unless cows can themselves contribute infection to their milk while apparently altogether free from any malady, points to the exculpation of this milk, viz., that, on August 10th, X. removed his cows to another farm, 2½ miles distant, at which they remained until September 23rd. During this time A. continued to convey X. milk, along with his own, into Folkestone. All the churns in which the milk was conveyed belonged to A., and were cleansed by him at his own farm. No sickness whatever is known to have occurred among X.'s cows

* One of the two medical men who saw these cases did not regard them as cases of enteric fever.

in 1899, nor among the persons at his second farm. For the first five weeks of the cows' stay at this second farm, only the water at that farm was made use of there; while, during the ten days or so immediately preceding their return to the first farm, water from the latter was also utilized owing to its having become scarce at the second farm. It will be remembered that, in Folkestone in 1899, notable amount of notification of cases of enteric fever referable to milk began on September 12th, and continued to the latter part of October, after which there were but few cases. If about 18 days be allowed for incubation of the disease and for sufficient development of its symptoms to permit its recognition and notification, serious degree of infection of the milk at fault would have been taking place about August 25th, and continuing up to about October 10th. At the first of these dates X.'s cows had been at his second farm for over two weeks; they had been brought back to the first farm 17 days before the second date. It is clear that during the early half or more of this period the conditions at X.'s first farm can have had no relation with the fever; and that the conditions, not free from risk as regards water supply, at his second farm, cannot be held accountable for infective material gaining access to the milk during the last 17 days of the period. But 15 cases that are to be regarded as having contracted the infection from A.X. milk subsequent to September 23rd were notified after October 11th, notifications of these cases continuing up to November 9th.

If the cases that occurred among consumers of A.X. milk prior to September be taken into consideration, the matter becomes still more difficult of explanation, if blame be attached to the X. portion of the A.X. milk. Apart from illness among the cows, of which there is no evidence, only on the remote hypothesis of continuity of infection derived in the first instance from X.'s first farm; then from X.'s second farm; and, finally, once more from X.'s first farm, can association of the infective material of the fever with X's milk be accounted for.

As regards A., there is no history of suspicious sickness about his household, nor of malady among his cows, in 1899. His water supply was derived from a rain-water tank within 20 feet of which were a cesspool for slop drainage and a cesspool for water-closet drainage, while the house drain passed close by this tank. In times of drought he supplemented this supply with water from a spring at another farm, conveying this water in his empty churns on his return journey from Folkestone. This spring is open to grave risk of dangerous pollution. Throughout the whole period of fever prevalence A. conveyed his own and X.'s milk in his own churns, washed on his own premises with water from one or other of the above sources. His relationship to the A.X. milk is the only constant factor of importance in connection with that milk as a fever agency; and, in logical sequence, the balance of evidence must be held to indicate that A.X. milk became infective because of that relationship, notwithstanding failure to discover the occurrence of any case of enteric fever about A.'s premises or about the farm with water from which he was wont to supplement his own supply.

In the course of my inquiries on this matter my attention was directed to the somewhat singular coincidence that the milkman who worked with X. in this year had acted in the same capacity on the two other farms which in 1896 and 1897 supplied the milk associated with fever in Folkestone in those years. The suggestion conveyed was that, if this person were of uncleanly habits, he might be the cause of these successive pollutions of milk with infective material. But no milkman, even if uncleanly in his ways, can convey infective material to milk unless that material be there to convey; which, as already pointed out, demands an assumption as regards X.'s two farms which cannot reasonably be entertained. Nor does the milkman in question appear to merit the suggestion implied as to his habits.

1900.

In this year 50 cases of enteric fever in 43 houses are known to have occurred in Folkestone. Of these cases, nine were distributed over the first seven months, followed in August, September, and October by material increase of the disease, which culminated in a sharp, if short, outbreak in early November, after which there was but little fever. Of the 50 cases, five were "imported."

The milk supply of the remaining 45 cases, which occurred in 38 houses, was furnished by 19 vendors. But in this year again there was exceptional incidence of the fever in houses supplied by certain of these vendors, as indicated in the following statement:—

Milk Vendor.	Number of Houses served by Milk Vendor.	Number of Cases of Enteric Fever in Houses served by Milk Vendor.	Number of Houses served by Milk Vendor invaded by Enteric Fever.	Percentage of Houses invaded by Enteric Fever.
				Per cent.
A. ...	100	6	6	6
C. ...	120	6	4	3·3
D. ...	250	16	11	4·4

The vendors referred to in this statement as A., C., and D. are the same as those referred to by the same letters in the tabular statement given under the year 1899. The one source of supply common to A., C., and D. in this year, as in 1899, was the milk already referred to as A.X. milk. The vendor described in 1899 as "B." did not take A.X. milk in 1900.

In this year A.X. milk was taken, not only by A., C., and D., but also by three other vendors, and was sold by them on their milk rounds. These three may be indicated by the letters E., F., and G. E. served 180 houses, and in two of the houses on

his round one case of the fever occurred in each, giving an incidence of 1·1 per cent. of the houses he supplied. F. served 50 houses; three houses on his round had each one case of the fever, giving an incidence of 6 per cent. G. served 100 houses; only one case of the fever occurred on his round.

Of these six vendors, A. and G. supplied A.X. milk only, while this milk constituted about a fifth of C.'s supply; about a fourth of D.'s supply; about an eighth of E.'s supply; and was taken only occasionally in small quantities by F. In view of the small number of houses invaded by the fever on some of these milk-rounds, close comparison between the numbers of these and the proportion of A.X. milk distributed cannot be made with safety. As regards incidence of the fever on D.'s round, it is noteworthy that six of the cases, occurring in one of the houses served by him, are not referable to the A.X. supply, since this house was, it is affirmed, served by D. with a milk which was totally separate from the A.X. milk as regards both source and manner of distribution. And yet the practical simultaneity of onset of the disease among these six persons, who were all notified as suffering from the fever on November 1st and 2nd, points to ingestion of infective material by food or milk, since water is not in question. On examination of this house, which was a girls' boarding school, at the time these cases of the fever occurred there, it was discovered that the drains were blocked, and, on application of the smoke test to them, smoke gained access to the scullery and the butler's pantry. It is, therefore, conceivable that milk or certain articles of food which were stored in these rooms might have become polluted by infective material that gained access to them by way of defective drains. In so far, therefore, as D.'s round is concerned, the fever referable to A.X. milk consists of 10 cases in 10 houses, an incidence of 4 per cent. on the houses served by him.

But, even if due allowance be made for smallness of figures, there is one singular feature as regards the distribution of the fever over these several milk-rounds in relation with the proportions of A.X. milk retailed by the respective vendors. This is the remarkable fact that only one case occurred among the 100 houses served by G. with A.X. milk only. To this fact reference will be made again. Be these things as they may, however, it is difficult to exculpate the A.X. supply from having, in 1900 as in 1899, been a medium of dissemination of enteric fever in Folkestone. For, out of the 45 cases not accounted for as "imported," 26 resided in houses, 24 in number, supplied with A.X. milk.

The incidence of the fever as regards sex is also consistent with milk having played a considerable part in its dissemination in 1900; 36 out of the 50 known cases in this year having been females. Of the 26 cases among persons that had consumed A.X. milk, 19 were females and seven were males.

These facts, indeed, point to the A.X. milk, infected in 1899, not having ceased to be dangerous in 1900. Most of the scattered cases of the fever in the first seven months of the year resided in houses supplied with this milk: and it would seem that the

infective material associated with this milk supply, after thus giving rise to individual cases at considerable intervals in the earlier months of the year, woke up to renewed activity under the more favourable conditions of August and later months.

As regards the question, which again arises, as to whether the A, milk or the X. milk was responsible for the dissemination of the fever in 1900, no guidance is afforded by fever having been known to exist on the premises of either A. or X. The condition of A.'s farm as regards water supply remained as before, and this supply was supplemented from the same spring as in 1899. The drains at X.'s farm had in the meantime been reconstructed, and, although bacillus coli was this year also found in the tank water referred to under 1899, the conditions of X.'s water supply were more satisfactory than those of A.'s. So far as there is presumption from local conditions at these two farms, it is against A. rather than X. And in relation with the vendor G. there is a feature in the distribution of the A.X. milk which goes to confirm this presumption. By special arrangement G. was furnished, not with the mixed A.X. milk, but always with X. milk unmixed with A. milk. He was the only one of the various vendors who did not take mixed A.X. milk; and, as already stated, notwithstanding his serving 100 houses, only one case of the fever is known to have occurred in these houses. But, had the X. milk been at fault, the proportion of cases on G.'s milk-round should have been much higher than on the round of any other vendor taking A.X. milk, since G. supplied unmixed X. milk, while the supplies of the other vendors were not wholly derived from X., and indeed, as regards most of them, were so derived in small part only. This consideration indicates that the milk responsible for dissemination of the fever in Folkestone in 1900, as in 1899, was not the X. milk, but the A. milk.

In 1900, apart from "imported" cases and cases in houses supplied with A.X. milk, there were 19 cases of the fever in 14 houses in Folkestone.

The facts which have been set out show that in 1896, 1897, 1899, and 1900 milk was a prominent factor in the dissemination of enteric fever in Folkestone, while it may have been reponsible for a small share of the fever in 1898. The singular feature of these repeated occurrences of enteric fever associated with milk is that three distinct sources of milk supply should have been involved in this relationship within the short period under consideration. Recurrences of the fever associated with the same milk supply would have been less remarkable, in so far as this would have suggested that the infective material of enteric fever had established and maintained a footing on or about a single farm from which milk was furnished. But there is a characteristic, common to many of the farms in the Elham and the Dover Rural Districts, whence large part of the milk supply of Folkestone comes, which may serve as a clue to there having been several sources of supply implicated in occurrences of the fever. This characteristic is scarcity of water supply, leading to the storage and use of water of quality so suspicious as that

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derived from the surface of roadways; to the use of water from wells or springs open to risk of dangerous pollution; and, in the event of failure or shortage of water supply on the farm, to the use of water procured from other premises without due regard to its quality. As already recounted, one or more of these conditions were in fact associated with the three milk supplies definitely concerned in the propagation of enteric fever in Folkestone in recent years.

These conditions are fraught with danger to the health of persons supplied with milk from such sources, and the Rural District Councils of Elham and Dover should take steps to secure a sufficient supply of pure water to all such dairy farms within their districts as are now deficient in this respect.

But the part definitely played by milk in the dissemination of enteric fever in Folkestone in the period of 1896–1900 cannot be accepted as a full explanation of the local increase of this fever during the five years in question over the amount known to have occurred in years immediately preceding. For, after deduction from the known cases of the fever in 1896–1900 all those definitely referable to infected milk or to shell-fish, and those "imported" or infected in the local hospital for infectious diseases, the last four of these five years still show considerably more fever than years immediately preceding. The numbers of cases in 1896–1900 not accounted for in one or other of the foregoing ways are as follows:—

Year.	Number of Cases.
1896	5 Cases in 4 houses.
1897	19 " 16 "
1898	23* " 22 "
1899	20 " 18 "
1900	19† " 14 "

It will be seen from these figures that in each of the four years 1897–1900 about 20 cases of enteric fever, not definitely referable to importation of the infection into the district by milk, nor accounted for in any of the other ways referred to above, are known to have occurred in Folkestone. This is much in excess of the usual amount of the fever in Folkestone prior to 1896, and calls for explanation.

It may be contended that some of these cases are attributable to their having consumed one or other of the infected milks without

* This number does not include the six cases in June and July suspected of having contracted the disease from milk.

† This number includes the six cases that occurred in a single house in November, probably referable to local infection of food or milk.

this fact having been detected, owing to the practice among milk vendors of occasionally supplying on their rounds small quantities of milk to other vendors whose stock may be running short. As a rule, no record is kept of these transactions, and there is much difficulty in tracing relationship brought about in this way between milk and fever.

But although there may have been occasional cases caused in Folkestone in this way, this hypothesis cannot properly be regarded as an adequate explanation of the matter. For it has to be remembered that in 1898, with the possible exception of six cases in June and July, milk did not give rise to enteric fever in Folkestone. So that, as regards that year, this view cannot be accepted. Further evidence against this hypothesis is to be found in the incidence of the fever as regards sex upon the cases now being considered. This was as follows :—

Year.	Number of Cases.
1897	19 Cases ; of whom 8 were Males and 11 Females.
1898	23 " " 13 " " 10 "
1899	20 " " 12 " " 8 "
1900	19 " " 5 " " 14 "
1897-1900	81 " " 38 " " 43 "

As regards individual years, these figures are too small to afford reliable deductions, but the totals of the four year period are not open to this objection. These totals show that the relative incidence of the fever, in view of the age distribution of the Folkestone population, was somewhat greater on males than on females. Had many of these 81 cases contracted the fever by drinking infected milk, the incidence, it is to be anticipated, would have been considerably greater on females than on males.

An explanation which fits the foregoing facts more readily is to be found in the view that the infective material of enteric fever, finding its way in considerable amount into Folkestone in 1896 by means of milk, and being on subsequent occasions reinforced in similar fashion, continued there in amount and under conditions that favoured the propagation of the disease. Among these conditions are to be reckoned the existence of faulty sewers and house drains referred to at an earlier stage of this report. Such sewers and drains would by permitting soakage of their contents into the surrounding ground facilitate access of the fever material to the neighbourhood of human habitations. It is possible, too, that the enteric fever bacillus thus brought into near relation with the human population of Folkestone found the meteorological conditions of recent years more than usually

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favourable to its viability, since these years have been warmer than the average. Whether the unusually low rainfall* in these years had a similar effect cannot be said, owing to want of definite knowledge as to the influence of this condition in Nature on the enteric fever micro-organism. Neither can the possibility of the fever material introduced into Folkestone, having been exceptionally tenacious of life and more than usually virulent, be overlooked. To one or other, or to a combination of these several conditions, the recurrences of so many cases of the fever, not referable to milk, in Folkestone in recent years may be attributed.

Sanitary Administration.

The sanitary administration of the Folkestone Urban District is in the hands of the Town Council.

The health staff consists of the Medical Officer of Health, who is also engaged in private practice, and who receives a salary of £200 per year; of an Inspector of Nuisances, who is also Building Inspector, and who gives his whole time to the duties of these two offices, and receives £200 per year in the former capacity and £50 per year in the latter capacity; of an Assistant Inspector of Nuisances, who gives his whole time to the duties of his office, and who receives 18*s*. a week; and of a clerk.

The internal administration of the health department is far from satisfactory. This is due to the relation in which the Medical Officer of Health and the Inspector of Nuisances stand to one another. The latter officer, who is active and zealous in the discharge of his duties, is apt to deal with questions which are not within the province of the Inspector of Nuisances, and to take independent action in matters in which supervision by the Medical Officer of Health is necessary. An illustration of this regrettable condition of affairs is afforded by the fact that the Medical Officer of Health and the Inspector of Nuisances have reported separately to the Health Committee as to the causation of the recent serious occurrences of enteric fever in Folkestone. These two officers differ in their conclusions: the Medical Officer of Health attributing material amount of the fever in 1900 to defective conditions of sewerage and drainage in Folkestone, a view not shared by the Inspector of Nuisances. It is no part of the duties of an Inspector of Nuisances to report upon the etiology of questions involving medical considerations, and it is much to be deplored that the Local Authority should have allowed such a procedure. The division of authority that obtains in the Folkestone health department is not conducive to the proper discharge of the duties which devolve upon it; and, in the interests of the public health, the Town Council should see to

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* Examination of the daily rainfall during the years 1896–1900 revealed no relation between particular occurrences of rainfall and appearances of fever. No information was available as to variations in the level of subsoil water during these years.

it that the relations between these two officers are arranged upon their proper basis.

The following adoptive Acts and byelaws are in force in the district:—

The Infectious Disease Prevention Act, adopted in 1890.

The Public Health Acts Amendment Act, adopted in 1890.

Byelaws with respect to new streets and buildings, allowed in 1880.

Byelaws with respect to slaughterhouses, allowed in 1858.

Byelaws with respect to common lodging houses, allowed in 1889.

There are no byelaws under the Public Health Acts Amendment Act, 1890, in force in the district; nor are there regulations under the Dairies and Cowsheds Order, 1885. The byelaws with respect to new streets and buildings are defective in several respects, notably in regard to open space in the rear of new buildings. While, in the main, an adequate amount of open space has been secured in the rear of buildings erected since 1880, there are nevertheless many instances of such buildings with insufficient open space in their rear. The clause regulating this condition requires revision. The Board have been pressing this matter on the attention of the Town Council for more than five years, but without definite result. The byelaws with respect to slaughter-houses are antiquated and lack several provisions desirable for the proper conduct of these places.

The Local Authority possess a hospital for infectious diseases, which, in addition to an administrative block and the usual outbuildings, consists of three ward-blocks and three wards in what is known as the "old administrative block." There is, at the rate of 2,000 cubic feet per bed, accommodation for 39 patients, distributed as follows:—

14 in a ward-block of 6 wards.
12 " " 2 wards.
10 " " 2 wards. (This is a temporary structure of wood and iron, erected in the latter part of 1899.)
3 in three small wards in the "old administrative block." These wards, however, do not afford 2,000 cubic feet per bed.

There is a steam disinfecting apparatus at the hospital for infectious diseases.

The following table* indicates the amount of work done in

* This Table indicates the work done under statutory notices. In addition, it is estimated by the Inspector of Nuisances that a large amount of work has been done in consequence of verbal requests by officers of the health department, and also by persons desirous of obtaining from that department a "sanitary certificate" as to the state of their premises.

recent years at the instance of the Local Authority with a view to securing abatement of nuisances :—

TABLE IV.

Work done in abating Nuisances.	1890.	1891.	1892.	1893.	1894.	1895.	1896.	1897.	1898.	1899.	1900.	Totals.
Drains, reconstructed, ventilated, and trapped.	—	1	31	37	63	57	43	96	31	27	182	568
Yards, sculleries, courts, and alleys paved with concrete.	146	136	62	75	81	45	41	35	53	31	105	810
Waterclosets provided with flushing cisterns.	112	94	128	145	95	56	48	52	82	114	150	1,043
Pan w.c.'s and D traps removed and replaced with those of modern construction.	112	94	128	145	35	24	19	8	5	9	19	598
Soil pipes brought outside and ventilated.	110	82	95	108	87	42	38	21	—	—	14	597
Bath waste, and other waste pipes made to discharge outside over proper trap gullies.	109	104	94	132	68	35	34	36	22	12	23	669
Bell and lip traps removed and replaced with traps of modern type.	102	91	30	41	28	14	25	11	18	21	32	413
Houses provided with proper spouting.	66	44	33	36	41	46	48	23	16	11	14	378
Blocked drains and w.c.'s cleansed.	55	64	38	48	58	63	64	77	33	17	32	547
Foul w.c. basins cleansed.	54	46	43	—	—	—	—	—	—	—	—	133
Separate drinking water from main provided.	42	37	36	29	22	8	9	15	—	—	2	200
Defective roofs repaired.	32	24	20	42	58	41	36	42	50	23	68	436
Storage cisterns covered and ventilated.	14	12	—	—	12	7	12	15	9	4	2	87
Cesspools emptied and cleansed.	—	3	—	—	—	—	—	—	—	9	9	21
Long hopper w.c. basins removed.	126	118	119	83	95	56	48	13	35	95	19	807
Fowls, animals, and wooden erections removed.	—	—	11	21	12	8	14	13	18	12	—	109
Accumulations of refuse removed.	—	—	13	15	23	18	15	18	18	8	21	149
Cesspools removed and station connected to sewer.	—	—	—	—	—	—	1	—	—	—	—	1
Drains trapped and ventilated, but not entirely reconstructed.	—	—	—	—	—	—	—	—	28	7	15	40
Proper galvanised iron covered dustbins provided.	—	—	—	—	—	—	—	84	210	253	304	851

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It is evident from these figures that a good deal has recently been done by the Local Authority in the way of effecting improvement in the general sanitary circumstances of the district. Much of the improvement brought about has been in relation with water-closets and their flushing arrangements, and with house drainage, while good work has also been done in securing proper paving of yards. In the last four years of the period comprised in the table considerable attention has, it will be seen, been given to the provision of proper dustbins; to which matter, as well as to the need for proper paving of yards, the attention of the Local Authority was directed by the Medical Officer of Health in 1897.

For the improvements effected by the Corporation in these various directions credit is due to them; but much yet remains to be done. There is still a considerable proportion of house drains that cannot be regarded as satisfactory, and proper disconnection of house drains from sewers is often lacking. The ultimate disposal of house refuse is a serious blot on the administration of the district. The present method is unsanitary and costly, and it is difficult to understand why the Corporation have not ere now abandoned it and provided for the ultimate disposal of house refuse by means of a destructor. The sewerage of Folkestone likewise requires the serious attention of the Town Council. In this matter, it is true, they have recently been effecting improvement, but it is needful that like action should continue until the whole sewerage system of the district can justly be regarded as in a satisfactory state. It is particularly desirable that the low-lying neighbourhoods, where sewage is apt to flood cellars, should be promptly dealt with; and the present main sewer outfall should be altered so as to secure that there shall be no deposit of offensive matters in the harbour or on the foreshore.

The housing of the poorer classes is another matter which requires the attention of the Town Council, inasmuch as there are areas in the older and more crowded part of the town which cannot well be dealt with save by a scheme under the Housing of the Working Classes Act, 1890. It is true that the Corporation have carried out a scheme, completed in 1900, under this Act, whereby they erected 50 houses for the working classes in the eastern portion of their district. But the class of house erected was quite unsuited to the end it was desired to attain; they contain six rooms each, and their average rental is 8*s*. per week. Houses with half or less than half this amount of accommodation, and letting at less than half this rental, are what is wanted; and this should in future be borne in mind by the Corporation in attempting to deal with this question.

The action of the Corporation in dealing with the current prevalences of enteric fever in their district in recent years was in the main satisfactory. As regards houses invaded by the fever, careful attention was paid to securing isolation of the sick from the healthy, as far as practicable. But the amount of accommodation at the hospital for infectious diseases proved inadequate in 1897, 1898, and 1899, at the end of which last year the

temporary wood and iron ward-block already referred to was erected. The numbers of cases of enteric fever removed to hospital in the period 1896–1900 were as follows:—In 1896, 1; in 1897, 10; in 1898, 12; in 1899, 48; in 1900, 32. Final disinfection of infected premises and articles was in all instances performed, and unsanitary conditions about the dwelling were remedied.

It may be thought that on certain occasions greater promptness might have been displayed by the local authority in prohibiting the supply to Folkestone of milk which was disseminating enteric fever in the district; but it has to be borne in mind that on such occasions the relationship of milk to the fever was obscure, at least in the earlier stages of fever prevalence, and that, accordingly, suspicion was not likely to fall upon this agency until the occurrence of a considerable number of cases afforded data sufficient to permit such an hypothesis. Illustration of the difficulties that stood in the way of acquiring data on which to base prompt and effective action, is afforded by the occurrences in 1899; when the milk prohibited was not the milk in fault, and when, even had the milk really in fault been prohibited, the prohibition would have come too late to be of material service.

The account which has been given of the sanitary administration of the district shows that, while the Local Authority have in recent years been displaying considerable activity in certain directions, it behoves them not only to continue that activity, but also to extend it to other matters to which they have not yet devoted sufficient attention. Prominent among the matters of the one or the other sort are the conditions of sewerage and house drainage in their district, the ultimate disposal of sewage and of house refuse, the housing of the poorer classes, and the revision of certain byelaws as already indicated.

No. 14.

Report on a Localised Outbreak of Enteric Fever at Coventry; by Dr. L. W. Darra Mair.

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In accordance with instructions I paid a brief visit to Coventry in September last, in order to make inquiry into a localised outbreak of enteric fever in a part of that town, and to confer with the Medical Officer of Health on the subject.

I ascertained the following particulars—

The incidence of enteric fever on the town of Coventry, and the mortality resulting therefrom, during the five years preceding 1901, is shown in the following table :—

Year.	Notified Cases of Enteric Fever.	Deaths from Enteric Fever.	Enteric Fever Death Rate per 1,000.
1896...	59	12	·21
1897...	25	3	·05
1898...	53	6	·10
1899...	126	18	·30
1900...	48	6	·09
Average	64	9	·15

The monthly incidence of enteric fever in Coventry during 1901 up to the end of September was as follows :—

Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
2	3	6	9	6	4	2	41	39

In Coventry the average yearly mortality resulting from enteric fever during the past five years compared favourably with the country as a whole, and nothing abnormal occurred in 1901 until August.

As shown above, 82 cases were notified in the third quarter of 1901. Of these 82 cases, 60 occurred among the inhabitants of one street and of the "courts" which are connected with it—namely, Sherbourne Street and its seven "courts."

Sherbourne Street is a "blind" street leading from a street called Spon Street, which is part of one of the main thoroughfares of Coventry.

The number of inhabited houses in Sherbourne Street is 38: and in the seven "courts" which are connected with it there are 48 other inhabited houses, making a total of 86 houses in the affected area. Many of the houses in these "courts" are built back-to-back.

In the following table the notifications received during the third quarter are set out in weekly periods for Sherbourne Street and its seven courts, and for the remainder of Coventry:—

Week ending.	Sherbourne Street Area. Notified Cases of Enteric Fever.	Remainder of Coventry. Notified Cases of Enteric Fever.
July 8	—	1
" 15	—	—
" 22	—	—
" 29	—	—
August 5	1	1
" 12	1	1
" 19	—	3
" 26	4	1
September 2	30	1
" 9	15	8
" 16	6	2
" 23	2	1
" 30	1	3
Totals	60	22

Among the particulars of this outbreak supplied to me by the Medical Officer of Health is a statement showing the approximate date of attack of each case in the Sherbourne Street area. The table below, summarised from that statement, shows the weekly

attacks in that area, together with the weekly number of houses freshly invaded :—

Week ending.	Sherbourne Street Area.	
	Cases.	Houses Freshly Invaded.
July 29	1	1
August 5	1	1
„ 12	—	—
„ 19	4	2
„ 26	21	9
September 2	17	7
„ 9	10	7
„ 16	3	1
„ 23	2	1
„ 30	1	—
Totals	60	29

These figures suffice to show what an explosive outbreak of enteric fever this was, that is to say, one characterised by the invasion of 29 out of 86 or more than one-third of the houses in the affected area, by its sudden appearance and rapid rise to a maximum, and, for enteric fever, a very rapid decline therefrom.

On September 3rd, the Medical Officer of Health prepared a report on the outbreak, which at that time involved 33 cases. He discussed at length various possible causes, and dismissed in turn water supply, milk supply, and food supply as factors in the outbreak. He also discussed whether certain alterations which had been carried out at the instance of the Corporation in connection with some of the houses could have been responsible for the outbreak. These alterations had involved disturbance of the floors and earth beneath in some of the houses and the reconstruction of some water-closets; but he pointed out that the incidence of the illness did not correspond exactly with the houses whose floors had been disturbed, and that the closets were not in proximity to the houses affected. He therefore dismissed the carrying out of these works as an explanation of the outbreak,

and finally concluded that the most probable cause was to be found in the habit which the children of this street had of playing in the River Sherbourne. This is a stream which in its course through Coventry flows past Sherbourne Street and one of its courts, namely, Court 4. Access to the river from this court is not prevented by any fence or other obstacle (*see* map).

In support of this contention he pointed to the existence of surface drains discharging into the river from Sherbourne Street and from Court 4, which "did not merely convey rain water": and to the fact that the outbreak unduly affected children under 15 years of age.

In my judgment the evidence in favour of this conclusion is not very strong. In the first instance, while the cause suggested is perhaps not an impossible one, it is at least not a probable explanation of such a localised explosive outbreak as this was, unless it can be shown that the habit of playing in the polluted stream is peculiar to the affected locality, and that no children other than those living in the affected area played in the stream at the spot in question. The stream is admittedly polluted, and the Sherbourne Street "Court 4" is only one "of a number" in Coventry "which are quite open to the river," and where, presumably, playing in the river may also be indulged in. Moreover, the evidence obtained by the Medical Officer of Health went to show that "large numbers of children find amusement in this way" at Sherbourne Street, so that it is not unsafe to conclude that children other than those living in Sherbourne Street join in this amusement.

For these reasons an outbreak due solely to the cause suggested by the Medical Officer of Health would be expected to have been more diffused.

Moreover, the age incidence of the outbreak, which the Medical Officer of Health relied upon as further support of his contention, does not seem to lend confirmation to his hypothesis. In the following table sex as well as age incidence of the disease as it affected the Sherbourne Street area is shown, and also the percentage of cases occurring in each of the age groups.

Ages.	Under 5	5—	10—	15—	20—	25—	30—	35 upwards.	Total.
Males ...	3	5	7	8	3	3	—	1	30
Females ...	2	5	8	8	3	1	—	2	30
Total ...	5	10	15	16	6	4	1	3	60
Percentage ...	8	17	25	27	10	6	2	5	—

This table shows that the bulk of the cases was among children and young persons between the ages of 5 and 20, but it also shows that there were actually more cases among females at these ages than among males. It is to be presumed that in the amusement of playing in the river, boys would far outnumber girls, so that the sex incidence of the cases tends really to discountenance the river playing as the principal cause of the epidemic. Moreover, the disease had as many victims between the ages of 15 and 20 as between those of 10 and 15, while the river cause would be expected to have affected only the age groups 5 to 10 and 10 to 15.

Leaving the Medical Officer of Health's suggestion of the cause of the outbreak, it may be considered whether in any of the alternatives discussed and dismissed by him there may not after all be found a more probable solution.

And, firstly, it cannot be doubted that an explosive outbreak of this sort is due most probably to infection by either (*a*) water, (*b*) milk, or (*c*) other food.

The strict localisation of the epidemic to Sherbourne Street and its courts does not support a food infection. Moreover, inquiries made by the Medical Officer of Health in regard to such articles of food as shell-fish and ice-cream led to negative results only.

Inquiries made by the Medical Officer of Health in regard to milk disclosed the fact that nearly all the invaded houses, and, indeed, the majority of the houses in Sherbourne Street and its courts obtained milk from a particular cowkeeper. This cowkeeper's milk-shop is close to Sherbourne Street, and his customers, with the exception of four or five, fetch their milk from the milk-shop, so that he has no milk-round. Consequently he had no record of his customers or of their number. But the Medical Officer of Health was able to elicit that the number of families served by this dairy must have approached 200; and as there are only 86 inhabited houses in Sherbourne Street and its courts, it follows that the majority of his customers lived elsewhere. There was no reason to suppose that the Sherbourne Street customers had on any occasion milk other than that supplied generally to his customers, so that since the epidemic was so strictly localised milk supply cannot but be dismissed as an explanation of the outbreak.

There now remains the water supply to be considered. The Medical Officer of Health in his report of September 3rd wrote as follows on this point:—

The whole of the houses concerned (*i.e.*, in Sherbourne Street area) are supplied with town water. Until one month ago the houses in Court 4 and the houses in front of them (20 houses in all) were supplied by a pump (*see* map). This pump water had been previously analysed and found to be good water. Town water was laid on to this court a month ago, not because any fault was found with the pump water, but because the town water was then being supplied for the first time to this property for use in some water-closets then being erected. Since that time both pump and town water have been available, and both have been in use for drinking purposes.

During the past week (on August 24th) I have taken a sample of the pump water and analysed it; chemically it shows no sign of organic pollution and, though this does not absolutely negative the possibility of its causing typhoid fever, it is fairly strong proof against it (*see* Addendum). Further, there are other invaded houses in Sherbourne Street and in Court 3 where no question of this pump water arises. . . . Although this and other indications are against the probability of this pump water being the source of the epidemic, yet, since town water is laid on to the houses in Court 4, there remains no need for the pump, which might with some be an object of suspicion. I have, therefore, affixed a notice to the pump that it is not to be used for drinking purposes, and further the handle of the pump has been tied up. Against the supposition that the public water supply could be the cause is the fact that the epidemic is so strictly limited.

On September 6th, the Medical Officer of Health again reported:—

The pump of Court 4, Sherbourne Street, has been more effectually closed by having its handle thrown out of gear. The well has been opened, emptied, and examined. The internal surface of the well does not show any appearance of any leakage of sewage matter. After emptying, it refilled in 2¼ hours, and in a way to suggest that its main source of supply is a spring rather than simply subsoil water. . . . In order to obtain fuller information concerning the water supply, I have submitted to the Public Analyst a sample of water from the pump in Court 4.

This sample was taken on September 1st (*see* Addendum).

Subsequently the Medical Officer of Health in a report dated September 17th, further wrote on this point:—

Up to August 31st, 44 patients (out of 55) had partaken of this pump water, and the pump water apparently obtained a reputation in regard to coolness and taste which gave it some pre-eminence over the ordinary tap water, even among people in this neighbourhood, who should not properly have partaken of this water, living as they do in houses not intended to be served by it. . . . On September 13th, I received from Dr. Bostock Hill, the Public Analyst, his analysis of this water (*see* Addendum). . . . Dr. Hill remarks in reference to the sample of water from pump at Court 4, Sherbourne Street, that "it contains very little fresh organic matter, and shows no evidence of any sewage pollution; in fact, for a pump water (and therefore drawn from a surface well as I presume) it is of remarkable purity. . . . I see no reason why it should be considered liable to injure health." In regard to the number of cases where this water had been partaken of and on which the suspicion of this pump was grounded, there are certain observations which I would offer. First of all, such a suspicion of the causation of an outbreak is militated against by the fact that not all of the affected persons had partaken of this water supply, and, secondly, many who had partaken were not affected. Further, if the numerical argument is to be applied in its entirety, greater suspicion attached to the milk supply than to the water supply, since no less than 46 patients have obtained their milk supply from the same source.

The fallacy of the last argument, however, is obvious. Before being able to maintain by numerical test that greater suspicion attached to a milk supply than to a water supply, it would be necessary to show on the one hand the ratio between the number of people consuming the suspected milk and the number of those consumers attacked, and, on the other hand, similar data regarding the suspected water supply. This unfortunately is not possible. Neither the number of consumers of the suspected milk, nor that of the consumers of the suspected water supply is known.

But analogous data as regards houses instead of persons are known, which throw some light on this point. The number of houses supplied with the suspected milk is approximately 200,

according to the investigations of the Medical Officer of Health, and the number of houses invaded by enteric fever in the affected area in which this milk was consumed was 20, a ratio of 10 per cent. On the other hand, inquiries made specially by the Medical Officer of Health for the purpose of this report, showed that in 49 of the 86 houses in Sherbourne Street and its courts, the suspected water had been consumed. The number of houses invaded with enteric fever where this water had been consumed was 22, a ratio of 45 per cent.

So that a numerical test instead of showing that the greater suspicion attached to the milk supply, actually makes the suspicion attaching to the pump water become a serious one.

Moreover, among the cases of enteric fever notified from other parts of Coventry was one notified during the week ended September 2nd (*see* Table, page 2), in a young man, who had visited a house in Sherbourne Street during the first week of August, and had there consumed some of the pump water.

But 7 houses in Sherbourne Street were invaded where it was alleged the pump water had not been consumed: that is to say 19 per cent. of the houses in the affected area where the pump water is said not to have been consumed were also invaded with the disease. This fact may seem to discount the probability of the epidemic having been caused by this water, but it does not necessarily do so. In epidemics due to water supply, it is the general experience for cases to arise which cannot be accounted for by the original cause. Such cases may occur in the later stages of the epidemic and be due to infection derived from earlier cases of the epidemic: moreover it is possible for cases to occur at any stage of an epidemic and to be due to causes independent of the epidemic cause, though such cases would be expected to be relatively few in number. It is also possible for such cases to be in reality due to the original cause, though, owing to the inaccuracy of the information elicited regarding water consumed, they may not appear to be so.

It may be that the cases (8 in number) which occurred in these seven houses could be accounted for by coming within one or other of the above categories. In two at least of the houses at any rate the cases, occurring as they did at the end of the epidemic, may almost certainly be regarded as "secondary" cases, Moreover it is to be noted that in the earliest stages of the epidemic—indeed until the epidemic reached its height—the occupants of every house infected admitted the use of the pump water. Whatever may be the true significance of the occurrence of cases in these houses, it is insufficient in itself to warrant the dismissal from further consideration of the pump water as the real cause of the epidemic.

It therefore becomes necessary to inquire whether any other circumstances connected with the epidemic pointed in the same direction.

But apart from such considerations, inquiry has shown that, as a matter of fact, the immediate neighbourhood of the well was subjected to very exceptional strain, and, moreover, at just the time when, if the well water was responsible for the bulk of the enteric fever, it must have been contaminated with infective material.

Reference has been made on page 215 to certain sanitary alterations which were carried out in connection with the houses in Court 4. These involved the reconstruction of a block of five water-closets at the back of the court. Two of the water-closets ware demolished on July 1st, and the new ones erected in their place were completed on July 13th. The remainder were demolished on July 15th, and the new ones erected in their stead were in turn completed on August 3rd. The result of this proceeding was that between July 15th and August 3rd, the inhabitants of Court 4, that is, of 16 houses including 4 houses facing Sherbourne Street, were provided with but two water-closets connected with their court, though it is said they could have used two waterclosets at the back of Nos. 23 and 24, Sherbourne Street, close to the Court. (*See* map.)

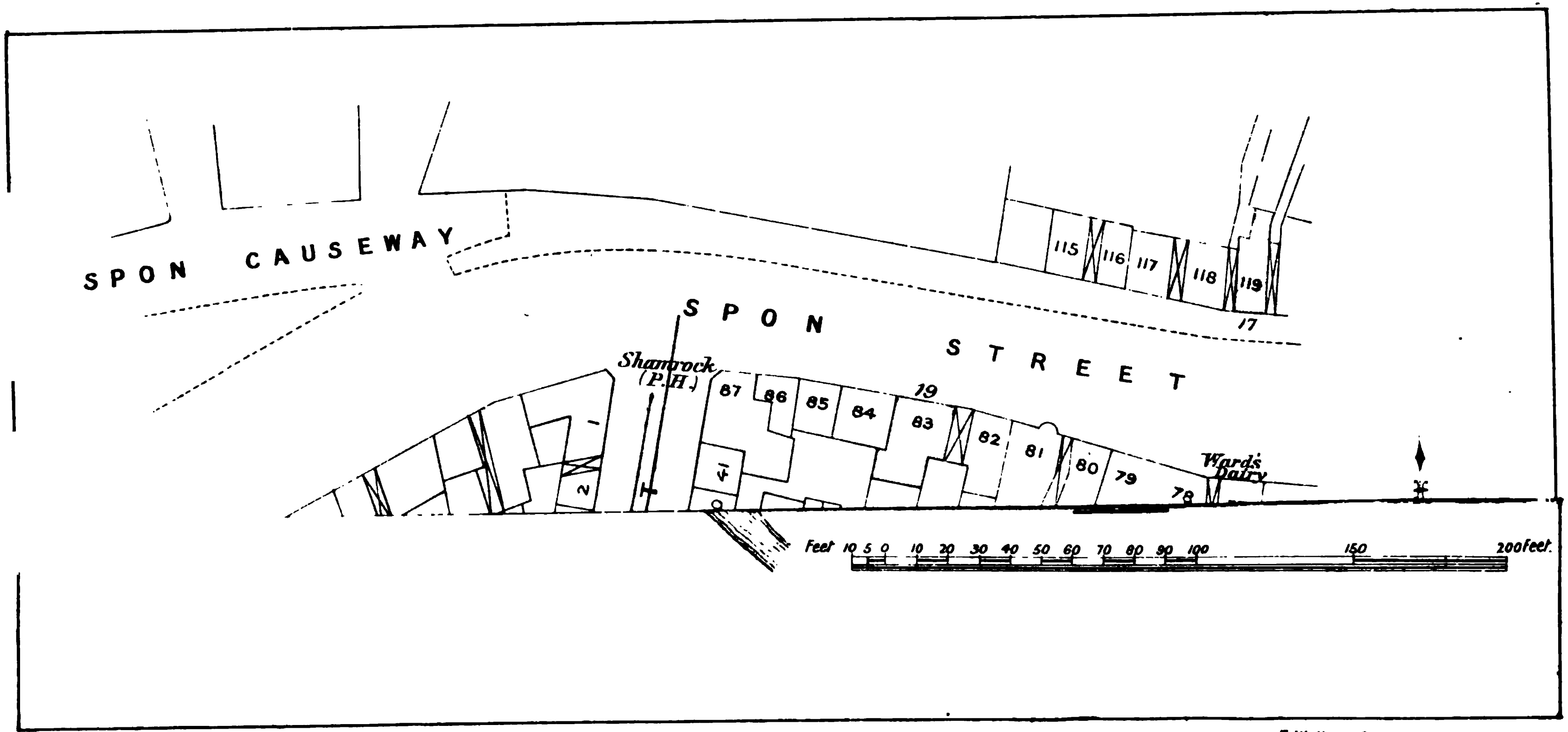
Though these closets are situated some distance from the well, it is obvious that, with such temporary inconvenience as this, the amount of excretal matters disposed of upon the paving of the court must have been very much increased—a danger complicated by the existence of two cases of enteric fever in two adjoining houses close to the well. To add to what must have been a general upset in the customary life of these people, the floors of all the houses in the court except four, were dug up and retiled.

But beyond these works, a very important alteration took place in the water supply. Up to this time, the only water available for the inhabitants of the court had been that from the well, which by an ingenious arrangement also supplied water for flushing the old water-closets. With the reconstruction of these closets, however, it was arranged to supply them with water from the main, and incidentally to also provide a drinking-water service from the main in Court 4, near the pump, by means of a stand pipe.

The map accompanying this report shows, *inter alia*, the position of the water-main in Sherbourne Street (blue line), and the position of the service pipes (red lines) which were laid in connection with the above works. These new service pipes were, it seems, laid at a depth of 2½ feet.

It will be observed from the map, that the service pipe supplying the tap in Court 4, was laid in close proximity to the well.

The construction of the necessary trenches and the laying of the pipes was carried out at the end of July. The pipe supplying the tap in the court, and the pipes supplying the new water-closets were inspected and passed by the Water Inspector on July 30th, after which the trenches were filled in: although it



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was not until August 12th, that water was turned on for drinking purposes, and not until August 19th that water from the main was turned on for the supply of the new closets.

It has been already pointed out that if the well in Court 4 was responsible for the bulk of the enteric fever, it must have received infective material just before or just after August 1st; and it seems not improbable that the carrying out of the above desirable sanitary improvements resulted, just about that time, in a temporary channel being made into the well, by which infective material reached it from the surface. The general confusion could only result in the fouling of the surface being far above the ordinary: but if it be assumed from what is known of the well, that pollution from the surface could not easily reach it, it may well be that it was not until the digging of the pipe trench near the pump that pollution, perhaps by a small but direct opening, was enabled to take place. It is to be noted, in this connection, that the water level in the well was about three feet from the surface, and that the new water pipe was laid 2½ feet from the surface

That infective material did actually reach the well in some such exceptional manner as this, receives confirmation from all the circumstances of the outbreak apart from the date of its commencement. This was, as has been shown, characterised by very sudden development to a maximum followed by still more rapid subsidence to a minimum. And if the pipe trench alone provided the channel for pollution, it follows that pollution took place for only the few days that the trench remained open; in other words that the water in the well received infective material only during that period. Laboratory observation has shown that if to a sample of water of considerable purity—such as the water of this well evidently was—be added a quantity of enteric fever micro-organisms, the latter rapidly disappear. In the case in question, it may be thought that what occurred was exactly similar: that is to say, that the well-water received infective material, perhaps small in amount, while the pipe trench remained open; that this access of such material ceased when the trench was filled in; and that thereafter the infective material already in the well rapidly dwindled to zero. In other words, the well water was capable of producing enteric fever among its consumers for a few days only: a circumstance which tallies with the sudden onset, short duration, and sudden cessation of the outbreak.

Moreover, the favourable nature of the chemical analyses and, so far as it went, also of the bacteriological examination of the water three or four weeks subsequently, is also accounted for.

Steps taken to cope with the Epidemic.

It was at an unfortunate time that this epidemic of enteric fever occurred. The Isolation Hospital belonging to the borough was not only in the hands of the builders, and undergoing extensive improvement, but such accommodation as was available was fully occupied by sufferers from scarlatina.

Under these circumstances no attempt was made to isolate in hospital any of the cases of enteric fever, beyond four which were admitted into the general hospital, until the end of September. At that time, by hastening on the building operations, a new pavilion containing accommodation for 30 beds was got ready, and efforts were made to cause those still suffering from the disease to be removed to the hospital. But now very few fresh cases were occurring, and with the exception of those few cases the advantage of hospital treatment was refused by the sufferers, of which there were then some 76, of whom 39 were convalescent, and 3 were too ill to be removed.

A printed form of instructions, detailing precautions to be adopted, was delivered at each infected house, and people were informed that disinfectants could be obtained from the Public Health Offices. The disinfectant issued was carbolic powder.

As regards the treatment of excreta, people were advised to disinfect them with this powder, and dispose of them in the water-closet. This must have involved much trouble and danger in Court 4, as has been pointed out, while the closets were disorganised, especially as they were also without water supply until August 19th, by which date four cases were in progress in this court. It is, indeed, questionable whether under the most favourable circumstances such a method of disposal of infective excreta is free from danger, especially in working-class dwellings; and, indeed, whether anything short of removal, daily or on alternate days, of such matters in specially-contrived receptacles can be regarded as adequate when a case of enteric fever is dealt with in an ordinary working-class dwelling—a procedure which is not difficult to carry out in practice.

The Coventry Nursing Institution undertook the nursing of the patients in the epidemic area, and the Medical Officer of Health has put on record in one of his reports his belief that the nurses of this Institution rendered very valuable assistance. In September a trained nurse was employed by the Corporation to act as a female health visitor. She also did useful work by visiting each infected house, and by giving "specific instructions concerning the proper disposal of excreta, of slops, and of washing water."

Beyond these measures the drains and gullies of the affected area were flushed with water and disinfectants.

In consequence of the opinion formed by the Medical Officer of Health as to the causation of the epidemic, no steps were at first taken to prevent the consumption of the well-water. However, on August 29th, the pump-handle was fixed, and later on it was put out of gear.

Remarks.

In the course of my inquiries, certain matters of administrative concern came to my notice, to which it is desirable to refer.

I have already alluded to the importance of dealing adequately with infective excreta in cases of enteric fever treated at home. The allied subject of the supply of disinfectants to infected houses also requires consideration in Coventry. Apart from the question of the legal authority for the distribution as above of disinfectants from the Public Health offices it is hardly satisfactory to rely upon the occupants of an infected house to fetch from one or another depôt, disinfectants for use during the existence of infectious disease in the house. And it is not necessary that they should be required to do so, if the inspectorial staff is adequate numerically: for with an adequate staff, it should be matter of routine for every infected house to be visited frequently by one or other of the inspectors of nuisances. Under such circumstances it becomes possible for the inspector himself to distribute and use such disinfectant as may be necessary, and to explain its use. In this connection, too, it may be questioned whether such a "disinfectant" as "carbolic powder" could not be replaced by one more reliable.

I have alluded to the Isolation Hospital. Much has been done of late by the Corporation of Coventry to provide adequate Isolation Hospital provision. A small-pox hospital has been built at Pinley, outside the borough, and building operations were going on at the City Hospital at the time of my visit to increase the accommodation of the administrative block, as well as to increase the patients' accommodation by the erection of the new pavilion containing some 30 beds. But there is in use an old factory, rented some years ago in a time of emergency, the employment of which ought to be discontinued for the treatment of sufferers from infectious disease. It is a long, one-storied building, which has been converted into two wards, with accommodation for some 30 patients. Besides defects connected with lighting and ventilation, its walls are very damp owing to the earth abutting on one side being much higher than the internal floor level. Moreover, nothing has been done to round off internal angles, while the boarded floor itself cannot be regarded as proper in these days for an infectious hospital.

It is questionable whether, even with the extensions now being brought to completion, this hospital will be large enough for the needs of Coventry, if the use of the above factory were to be abandoned; but there can be but one opinion that its use ought to be abandoned. So that it seems to follow that the Corporation ought to consider without delay the question of erecting another hospital block to replace this factory.

During my inquiry, it came to my knowledge that the Rev. A. G. Robinson, Rector of St. John's parish, through whose instrumentality the services of the nurses of the Coventry Nursing Institution became available and were so valuable owing to the absence of hospital provision, had also made arrangements for convalescent sufferers to be lodged in farm houses and other dwellings in the neighbourhood of Coventry. As an outcome of his kindly action, it appeared that some of the sufferers had been so provided for long before such sufferers could be regarded

as non-infective. For instance, in more than one case, sufferers had gone away after illness of not more than 14 days' duration.

I pointed out to the Medical Officer of Health the danger of this procedure, especially as patients were being sent to farm houses where the possibility of milk infection was to be thought of, but he contended that as the Rector presumably obtained the medical attendant's permission prior to the removal of a convalescent, he was powerless to interfere, although he concurred as to the danger attending the practice. But I disagreed with the Medical Officer of Health. Though he might be legally "powerless to interfere" if sanction to the removal of a sufferer from an infectious disease had been given by a medical attendant, it would nevertheless be right that he should utter a word of warning to all responsible where such removal might conceivably have dangerous results.

I saw the Rev. A. G. Robinson on this matter and explained to him the danger that was being incurred by his charitable endeavour to do good to these sufferers: and he, without hesitation, expressed his readiness to consult the Medical Officer of Health in future before sending any convalescent out of Coventry.

I would venture, in conclusion, to urge that in matters cognate to the existence of infectious disease in a community, a Medical Officer of Health should not always consider whether there is legal power to enforce any view he may hold or any advice he may deem desirable. Much may be done and has been done by an officer so responsible as a Medical Officer of Health to prevent danger by well-considered warning, protest, advice, and so forth, which could not be done were he to refrain merely because he felt himself legally "powerless to interfere."

ADDENDUM.

* The following are the particulars of the various examinations which were made of water taken from the well in Court 4.

I.—Analysis by Dr. Snell, the Medical Officer of Health, of a sample taken on August 24th.

Water clear and bright.

Total hardness	25	parts per 100,000.
Chlorine	1·8	
Free Ammonia	·002	
Albuminoid Ammonia	·0036	

Nitrogen as Nitrates and Nitrites—traces only.

II.—Analysis by Dr. Bostock Hill, the Public Analyst, of a sample taken on September 1st.

	In parts per 100,000.
Total solid impurity	34
Free Ammonia	0
Organic Ammonia	·002
Nitrogen as Nitrates and Nitrites	·22
Oxygen absorbed in four hours	·018
Chlorine	2·
Hardness—	
Temporary	11·26
Permanent	9·82
Total	21·08

Concerning this analysis, Dr. Hill reported on September 13th :—

"In reference to the sample of water from pump at Court 4, Sherbourne Street, it contains very little fresh organic matter, and shows no evidence of any sewage pollution; in fact, for a pump water (and therefore drawn from a surface well, as I presume), it is of remarkable purity, while it is considerably softer than the tap water supplied at the same time. I see no reason why it should be considered liable to injure health.

III.—On October 14th, Dr. Hill wrote as follows to the Medical Officer of Health :—

"Recognising the importance of investigating into the presence or otherwise of the typhoid organism in the sample of water from 'pump, Court 4.' Sherbourne Street, I forwarded a sample of it to the bacteriological laboratory of the University of Birmingham. As a result of a detailed and lengthy examination by the most modern methods, Professor Leith tells me that he cannot discover the existence of the typhoid bacillus. He says :—

"'To sum up my findings practically

"'(1) I have failed to find the typhoid bacillus.

"'(2) I have failed to find the colon bacillus, ordinarily known to us in its several races inhabiting the fæces.

"'(3) I have failed to find any organism in the water indicating fæcal or sewage contamination, and

"'(4) Bacteriologically the water is pure, but the amount at my disposal was rather small for all purposes.'

"You will see, therefore, that the bacteriological result fully corroborates my own opinion based on chemical methods, and I have not the least hesitation in stating the opinion that this water could not have had anything whatever to do with the outbreak of typhoid fever."

As regards this bacteriological examination, it is to be noted that the sample sent to Professor Leith was a portion of the sample sent to Dr. Bostock Hill, which was obtained from the pump on September 1st. Professor Leith stated that he did not receive his sample until September 13th, and that it measured but 185 c.c., see p. 221.

No. 15.

APP. A, No. 15.

On Enteric Fever in Whitehaven and the Sanitary Administration of the Town Council; by Dr. Bulstrode.

REPORT upon an OUTBREAK of ENTERIC FEVER in the BOROUGH of WHITEHAVEN, and upon the SANITARY ADMINISTRATION of the TOWN COUNCIL; by DR. H. TIMBRELL BULSTRODE.

The circumstances which led up to the inspection to which this report relates were as follows :—

On September 8th, 1901, the weekly notification return for Whitehaven showed that during the week ended September 7th 15 cases of enteric fever had been notified in the borough, and on September 21st a special report on the outbreak by the Medical Officer of Health was received by the Board. On September 23rd the following resolution was forwarded to the Board by the Town Council :—

That, having regard to the serious outbreak of enteric fever referred to in the Medical Officer's Report, the Local Government Board be asked to hold an inquiry in order that the matter may be thoroughly investigated.

The Board decided, having in view the past history of Whitehaven in respect of fever of one or another type, to accede to the request of the Town Council, and I received instructions to inquire into the outbreak.

Topographical and Commercial Considerations.—The borough of Whitehaven is situated on the Cumberland coast a few miles to the north of the promontory known as St. Bees Head. The town for the most part lies in what is practically a narrow valley, on either side of which the hills rise up to a considerable elevation. The houses are built partly on sand, partly on clay, and partly on the coal measures. The main industry of the population is coal mining, but there are also ironworks. There is a convenient harbour from which vessels sail at regular intervals to Belfast, Liverpool and the Isle of Man, and there is a considerable local fishing industry.

The chief imports of the district are iron ore from Spain, grain from the River Plate, and timber from the Baltic and America. The chief export is pig iron.

Whitehaven was incorporated by charter in July, 1894, and at that time the harbour, which before had formed part of the Whitehaven Rural District, was transferred to the borough.

Population.—The following figures are taken from the preliminary census returns of 1901 :—

Year.	Inhabited Houses.	Population.
1891	3,848	19,370
1901	3,968	19,325

It will thus be seen that not only was there no increase of population during the last decade, but that, on the contrary, there was an actual decrease of 45, and this notwithstanding the fact that in 1901 there was an extension of the borough boundaries in such fashion as to add to the borough a part of the parishes of Preston Quarter and Moresby, both formerly belonging to the rural district. Such extension was, however, responsible for the addition of only a very few persons to the population.

Water Supply.—In the matter of water supply Whitehaven occupies a somewhat historical position, the town having been the first in this country to be supplied from a natural lake.

Up to 1867 the water supply of Whitehaven was derived from the River Ehen shortly after its exit from the western end of Lake Ennerdale, but in this year the intake was, as a matter of precaution, removed to the lake itself.

This lake, which is situated about 10 miles to the east of Whitehaven, has a length of 2½ miles, a breadth of ¾, and a depth of some 80 feet; its elevation is 369 feet O.D.

At the present time there are two iron conduits conveying water from the lake, the one 15 inches in diameter, the other 12 inches. The pipes are suspended in the water of the lake in such a way as to exclude both floating and sedimentary matters, and over the mouth of each pipe is a screen arranged so as to prevent the ingress of solids. The water is measured as it passes through a gauging house, the Corporation now possessing statutory powers to extract 2,000,000 gallons from the lake daily.

The head of water before reaching the Scragill Reservoir, which is uncovered and situated at 307 O.D., is utilized for pumping up a portion of the water to the high service reservoirs situated, the one at Harras, the other near the cemetery. The remainder passes on towards the Scragill Reservoir: one pipe enters a channel in the floor of the reservoir, the other passes round it. As a general rule the whole of this water passes through the channel in the floor of the reservoir, such channel being covered by a layer of filtering material. If the supply is in excess of the demand the water passes up through the filter into the reservoir; if the reverse condition obtains the water in the reservoir passes downwards through the filter into the channel already referred to. The other pipe which passes round the reservoir can be used if repairs are taking place in the reservoir, or if the filtering material is being replaced or cleansed. In a word an uncertain portion of the water which supplies the lower lying part of Whitehaven undergoes both upward and downward filtration, but the main object of the filter is, I understood, to filter such water as has been standing in the uncovered reservoir. The filtering material did not appear to me, from the information which I received from the surveyor, to have been changed or cleansed in the past as often as might have been desired, but I think a more frequent cleansing will now be practised.

The water which is pumped up to the Harras reservoir, which has an elevation of 500 feet O.D., and with a capacity of

150,000 gallons, supplies the inhabitants of the high level portion of the town with the exception of part of the village of Hensingham, which is supplied by the "cemetery" reservoir situated at an elevation of 380 feet O.D.

The two high level reservoirs together supply a population of 5,410.

The supply of water is said to be now adequate, the Corporation having recently obtained Parliamentary powers for taking an additional amount from the lake. Over and above the water furnished to Whitehaven itself, a population of 20,000, water is supplied to an extension of the town situated in the rural district and known as "Preston Quarter," as also to Hensingham and to a portion of Moresby, *i.e.*, about 25,000 persons are supplied with water from the lake. It is estimated that about 40 gallons of water are supplied per head of the population.

The water has shown no evidence of plumbo-solvent power, but no lead cisterns are used. Some of the iron pipes become at times corroded and blocked.

The better-class houses are supplied separately, but in the courts and alleys where the poor live there are standpipes at uncertain intervals.

The quality of the water would appear to be satisfactory, but at times there have been complaints as to the bad odours possessed by the water (*see* analyses annexed, Addendum No. 1).

The catchment area of Ennerdale Lake consists partly of Lower Silurian (altered shales) and partly of intrusive igneous formation (Ennerdale Syenite), these being bare or more or less covered with herbage, peat, or moss.

There are but few houses in the neighbourhood of the lake, and although any pollution which might reach the waters of the lake from these sources can be relatively very small, it would, it seemed to me, be desirable that from time to time a survey of the area should be made with a view to ascertaining the precise methods of disposal of sewage and slop water adopted within the catchment area.

Sewerage.—The town was sewered in 1866 by Mr. Hawkesley, the sewage being conducted to a common pumping centre at what is now the electric lighting station near the harbour, and from here it is conveyed by means of a long capacious culvert to the outfall situated on the shore to the west of the town.

As a general rule pumping is not necessary, but in times of heavy storms the pumps are brought into action to prevent the sewage from heading back into the town sewers. The outlet is governed by a tidal valve, and at, or near, high water the sewage is held back in the culvert already referred to. Such culvert does not however extend beyond the pumping station, and any heading back inland of this point is guarded against by the provision of pumps. The sewage is discharged crude. In

addition to the main outfall there is another to the south which takes the sewage of the houses in the neighbourhood. Ventilation is provided for by surface gratings, by shafts, and by chimneys.

This latter method is, according to the surveyor, quite satisfactory.

Flushing is carried out by means of four automatic tanks of 250–340 gallons capacity, and 30 other tanks of 50–250 gallons capacity.

The older sewers are clay jointed, but where renovations are made the pipes are jointed in cement. The surveyor does not attach much importance to the clay joints in view of the fact that so much of the subsoil is itself clay.

The sewerage system is in a large part a "separate" system, a considerable portion of the storm water finding its way into one or other of the three streams which traverse the town, but which are now almost entirely covered over.

House Drainage.—In the older parts of the town, and more particularly in the locality where the outbreak here in question occurred, the precise position of the drains is not known. It is clear that in many cases the drains must pass beneath the houses. Ventilation of the house drain in the poorer property is altogether the exception, as also are any facilities for inspection, and it would seem that the houses are often not properly disconnected from the sewers. In many instances there is no inside sink to the houses, the slops being disposed of down an outside gully. The traps covering these gullies are at times defective.

Excrement Disposal and Removal.—Excrement is disposed of almost exclusively by water closets, and all those closets seen by me were provided with proper flushing apparatus. In many instances the closet accommodation is not sufficient, and this fact has received prominent notice in the reports of the Medical Officer of Health. Endeavours are, I understood, made to provide at least one closet for each two houses, in which case the closet is often duly numbered and locked, the key being kept by those alone who have right of access thereto; but, owing to the appalling overcrowding of houses upon area, the closets are at times situated in altogether insanitary positions, and cannot fail to be a very serious nuisance to the occupants of adjoining houses. In one instance which I saw the closet was situated in an absolutely dark room leading immediately out of the sitting-room. There was apparently no ventilation other than into the dwelling-room, where aerated drinks were on sale. In another it was situated immediately beneath the staircase leading to several tenements, and the closet appeared to ventilate itself directly into such staircase. In other instances the closet serving two houses was situated immediately between the two rooms which were used as kitchens, and it was easy to pass from one house to the other through the w.c. In these cases the closets ventilate directly into the kitchens, in one of which bread was being

baked at the time of my visit. In other cases the closets are, as it were, crowded into any nook or cranny abutting upon the narrow passages and alleys which abound in Whitehaven, and which will be further referred to in considering the conditions under which the Whitehaven poor are housed.

Refuse Disposal and Removal.—As a general practice refuse is deposited outside the houses in pans, pails, or other uncovered receptacles. In some parts of the town there are capacious ashpits, and these may be found in part of the area invaded by enteric fever. Scavenging is performed by the sanitary authority, and there is a daily collection. The refuse is emptied into hopper barges, and taken out to sea. This latter provision is an improvement on the condition of affairs in 1885, when the Board's Inspector, Dr. Blaxall, found the refuse deposited upon the beach, to be removed therefrom by the tides.

Isolation Accommodation.—The Isolation Hospital, which is situated in an elevated and exposed situation (260 feet O.D.) to the north of the town, and about a mile from the docks, consists of a permanent stone structure, erected in 1892 out of borrowed money.

The site is 1½ acres in extent, well isolated, and surrounded by a stone wall 7 feet in height.

The permanent buildings consist of a 10-bed pavilion—*i.e.*, a 6-bed ward and a 4-bed ward separated from one another by a nurses' room. There is also a 6-bed isolation block arranged after the Board's model.

The drains are well arranged, and flushed by automatic tanks.

The administrative block consists of what served formerly as the hospital itself, there being three rooms on the ground floor, and four on the first floor, in addition to a bath room. The administrative block is in telephonic communication with the town, and friends are therefore able to ascertain the progress of the patients without visiting the hospital.

Temporary Building.—Owing to the outbreak of enteric fever to which this report has reference, a corrugated iron ward has been erected near to the existing building. It contained eight beds.

The hospital is in charge of a lay superintendent and his wife, and nurses are employed according to the exigencies of the situation. It is not, however, a rule that only trained nurses shall be engaged.

Generally speaking, the hospital was at the time of my visit well arranged, and in a cleanly condition, but there is, I was told, room for improvement in the matter of the provision of hot water.

The ambulance is a well constructed modern conveyance, which is suitably housed.

The mortuary is situated next to the ambulance house, there being a fixed inspection window in the intervening partiton.

Disinfecting Chamber and Apparatus.—The Reck's apparatus provided is a modern machine fitted in the wall which separates the two compartments of the disinfecting building, the boiler and furnaces being on that side which is used for the disinfection of articles. This arrangement facilitates the drying process.

Such articles as can neither be disinfected or boiled are dusted with carbolic acid powder.

The Housing of the Whitehaven Poor.—The late Dr. Bristowe, of the Privy Council Office, made an inspection of Whitehaven as far back as 1863, and the graphic description which he then gave of its courts and alleys, and which is referred to later in this report, is as applicable now as when it was written.

In so far as the housing of the Whitehaven poor is concerned the unsatisfactory housing of the working classes remains, generally speaking, as before.

Wherever one turns, whether out of the small or the large thoroughfares, one finds deplorable courts and alleys where the direct rays of the sun are but rarely seen, and where even its diffused light is often difficult of attainment. The alleys all too frequently consist of narrow channels often not more than 3 to 3½ feet across, on either side of which the houses face one another. The alleys are approached by narrow passages which pass either through or by the side of the houses facing the streets, and it is immediately behind this front row of houses that the alleys are found. At the further end of the alley there is commonly another house; and hence it comes about that these alleys are practically closed at both ends, while the sides are composed of the two and of the three-storied houses, which are separated from one another by only an interval of some 3 to 3½ feet. Any odd nook or corner has to serve for the w.c., or where no such space is available the convenience is situated at some distance from the alley.

The houses situated in these alleys are frequently either back to back or they have no back light, and hence the amount of light which is to be obtained on the ground floor of these dwellings is extremely small. The "overlooking" which is a consequence of this over-crowding of dwellings upon area necessitates the drawing down of blinds when anything approaching domestic privacy is desired.

The demand for dwelling houses which obtained at the time of Whitehaven's greater prosperity is apparently responsible for the present overcrowding of houses. It was then—there being at that time no proper building byelaws in force—that the gardens and backyards belonging to the houses then existing were given over to the enterprising builder, who soon converted every available patch of ground into a court or alley. The overcrowding which has resulted is almost unique in my experience.

APP. A, No. 15.

On Enteric Fever in Whitehaven and the Sanitary Administration of the Town Council; by Dr. Bulstrode.

Although much good work has undoubtedly been done with respect to the artificial lighting of these courts and alleys at night, there are still many such where a stranger must literally grope his way.

I could not ascertain that any very serious attempts had been made to bring more light and air into these depressing localities: whatever attempts had been made had not been very successful.

There is, I was told, great difficulty in procuring freehold land in the vicinity of Whitehaven, and although leasehold property may be had the conditions as regards length of lease are not, I was informed, such as to tempt building societies or private persons to venture on building enterprises.

Houses are I understand very difficult to procure, and for an empty abode there is much competition. But little overcrowding of persons in Whitehaven came under my personal notice.

I am quite alive to the difficulty of dealing in a wholesale fashion with the problem here in question, and the fact of this acknowledged difficulty seems, as far as I can understand, to have deterred successive sanitary authorities from facing the situation. But because the unsatisfactory condition of affairs at present obtaining cannot at once be wholly removed, it is to be deplored that the borough councillors should adopt a policy of inactivity. For instance it is difficult to imagine a place better fitted for the application of Part II. of the Housing of the Working Classes Acts than Whitehaven. The removal here and there of the most insanitary and obstructive buildings would effect an enormous improvement as regards light and air.

But the chief reforming force operative in Whitehaven would seem to be the destructive influence of time and weather, which, by its ravages, gradually renders houses untenantable so that the inmates of their own initiative decline to occupy them. But even in cases such as these the houses are allowed to remain, and although uninhabitable, to obstruct ventilation and light, and to preclude the possibility of proper closet and yard accommodation for the adjoining houses.

It is to be regretted that those who for successive generations have been responsible for the sanitary condition of Whitehaven have not seen their way to set a higher standard.

I would suggest that a small sub-committee of the corporation, with their officers, should inspect the town with a view of ascertaining whether Part II. of the Housing of the Working Classes Act, 1890, might not be applied in certain cases.

Furthermore, if the present deplorable condition of affairs is to be materially and generally improved, Whitehaven town should be permitted to grow beyond the limits to which at present it is restricted. I quite agree with Mr. Fisher, the Medical Officer of Health, when he advocates in his last annual report "the provision of healthy well-ventilated cottage property, at a moderate rent, outside the already overcrowded area." The

difficulty of procuring land ought not to be allowed to stand in the way of the provision of better housing accommodation.

Common Lodging Houses.—I visited three out of the four common lodging houses in Whitehaven, but in none of them did I find the copies of the byelaws which are provided for by section 25 of such byelaws. In two of the lodging-houses there were no notices appended to the doors, showing the number of inmates for which the rooms were licensed.

In one lodging house the general conditions were filthy, in another they were indifferent, in the third the premises were cleanly. The lodging houses in Whitehaven are under the control of the police. The sanitary authority made the byelaws which are supposed to control them, and I would suggest that they should make inquiries into the matter. Dr. Blaxall, who inspected Whitehaven in 1885, drew attention to the fact that the lodging houses were then inspected by the police, and he pointed out the advantage of inspection by the officer of the sanitary authority.

Dairies, Cowsheds, and Milkshops.—In Whitehaven milk is distributed in carts coming direct from the cowsheds, and there are but few milkshops or dairies in the town. I visited three cowsheds. In two of these the conditions as regards cleanliness and light were not satisfactory. I was told by the Medical Officer of Health and Inspector of Nuisances that the control of these cowsheds rested with the Veterinary Inspector. Adequate Regulations for their management should be drawn up and enforced.

Slaughter Houses.—I inspected several of these. In no case had the attempts to enforce the byelaws been entirely successful; the walls had not been whitewashed at the prescribed times, and in no instance were covered receptacles provided.

The Medical Officer of Health has for some years urged the desirability of erecting a public abattoir, but up to the present without success. It is clearly impracticable for animals and meat to be properly inspected when slaughtering takes place at different places and at irregular times. In one of the slaughter houses at Whitehaven the conditions approximate somewhat to a public slaughter house, there being several separate compartments which are let to different butchers. At this place pigs are largely slaughtered. The practice of stunning the animal prior to bleeding it was here adopted. This practice is common in the large central Vieh-hof at Berlin where, in place of the piercing cries which usually characterise pig slaughter, a remarkable stillness obtains. Apparently this method of slaughtering in no way interferes with the excellence of the meat, or the sale of the pig's head.

Adoptive Acts.—The Council have adopted the following Acts:—

1. Public Health Acts Amendment Act, 1890, Parts 1, 2 and 3, adopted April 7, 1891.
2. The Infectious Disease (Prevention) Act, 1890, Part 1.

Regulations.—Regulations under the Dairies, Cowsheds, and Milkshops Orders were adopted in 1899, and provision was made for their coming into force on January 1901. The regulations are, however, unsatisfactory as to cubic space and other matters, and the Town Council have been asked by the Board to amend them.

The past history of Whitehaven in respect of Enteric Fever.—The sixth report of the Medical Officer of the Privy Council (1863) contains an extract from a report by Dr. Bristowe upon enteric fever in Whitehaven. In that report the author states that, according to the information furnished to him, fever had been very common in Whitehaven up to 14 years anterior to 1862, but that during that year twenty-one deaths from fever were registered in the Whitehaven sub-district.

In the spring of 1863 a sudden outburst of fever occurred in a group of 40 houses known as Capel Terrace, near Hensingham, about two miles from Whitehaven, and in the latter part of July fever broke out simultaneously all over Whitehaven, attacking all classes of the inhabitants. Dr. Bristowe was informed by the medical practitioners of the town that they had attended, in July, 1,000 cases, and from the beginning of July to September 1st, 30 persons died of the disease in Whitehaven. The disease seems to have manifested a considerable degree of infectivity, so much so that Dr. Bristowe was at first inclined to regard the outbreak as one of typhus and not enteric fever, but he subsequently satisfied himself that he had to do with the latter disease.

The sanitary condition of Whitehaven was at that time such that Dr. Bristowe wrote—"I have no hesitation in asserting that there is no English town with which I am acquainted where the sanitary circumstances (with one or two exceptions) of the inhabitants, and especially of the poor, are in a more disgraceful and degrading condition. The houses of the labouring population (more particularly in the central parts of the town) are crowded together in a way which is scarcely conceivable; the houses, themselves, are for the most part dirty, dilapidated, and imperfectly (if at all) ventilated; they are overcrowded and the cellars are habitually let out as tenements; houses, courts, and even streets are without any privy accommodation, and where privies are provided they are of the most objectionable kind, and generally most objectionable as regards their situation; drainage scarcely exists."

The Medical Officer of Health has been good enough to furnish me with figures relative to the prevalence of enteric fever in Whitehaven from 1884 to the present time—that is to say in so far as such prevalence, in the absence of compulsory notification prior to 1890, could be ascertained.

It would appear from these figures that in 1884 there was an extensive epidemic of enteric fever, as no less than 37 cases were treated in hospital. The outbreak was apparently mild in character, since there were but two deaths among the 37 cases. This outbreak was, like the one now under consideration, confined to a more or less circumscribed area situated at Mount Pleasant, one

of the most insanitary and dilapidated portions of the borough, where houses have been vacated owing to the fact that they were no longer capable of sheltering the inmates. Many of these houses were, Mr. Fisher tells me, closed by the action of the Sanitary Authority. From 1890 down to the present time the notified cases of enteric fever and continued fever have been as follows :—

Year.	Cases.	Remarks.
1890	10	62 cases of typhus fever.
1891	18	
1892	15	7 cases of continued fever.
1893	13	1 " " "
1894	9	
1895	14	1 " " "
1896	8	1 " " "
1897	8	
1898	12	1 " " "
1899	13	
1900	4	1 " " "
1901	83	3 " " "

The present Outbreak of Enteric Fever.—As will have been seen by the preceding table, the year 1900 was relatively free from enteric fever, there having been but four cases notified as such, and one as continued fever. During the first three months of 1901 but five cases of this disease were notified, and, indeed, until July 5th but six such cases came to the knowledge of the Medical Officer of Health; but in August there were eleven cases, and in September thirty-two, the monthly records for each month of the year being as follows :—

January	2
March	3
May	1
July	3
August	11
September	32
October	7
November	8
December	16
TOTAL	83

The Distribution of the Cases.—The cases have been very largely limited to an area of Whitehaven situated to the south of the town, and comprising one group of houses known as "Newhouses," and another group known as "Ginns," this latter including also Cummins Lane.

"Newhouses" consists of three long rows of houses built in successive tiers, one above the other, on the side of a material declivity. The configuration of the ground necessitated many of the houses being built in an excavation, the front of which forms the back of the houses. In these instances the lighting and ventilation of the back room, which is used as a kitchen, is furnished by means of a skylight in the roof. There are no sinks in connection with the houses, and the closets are often situated at some distance from the houses to which they belong. In cases where there is a small backyard the closet is at times situated inconveniently near to the doors and windows of the houses abutting upon the yard. As a general rule, however, the closets are now situated in pairs not far from the dwelling, efforts having been recently made to provide one closet for two houses. The prevailing method of refuse disposal is by means of open pails, which are deposited in the front of the houses until their contents are taken away by the dustcart. In some instances large ashpits are still in vogue. The drains in the invaded area appear to have been in an eminently unsatisfactory condition. Generally there is no ventilation to the house drains, and their exact course is often unknown. The borough surveyor has, however, made a thorough investigation of the drainage of the invaded houses, and he has, he tells us, found numerous defects, such as broken drains running immediately beneath the floors of houses, absence of trapping and ventilation, and other conditions prone to cause the pollution of the soil and air of the houses in question.

The general condition of the invaded property is thus well described by the Medical Officer of Health in a special report upon the outbreak, dated September 13, 1901:—

> "It must be recognised that in the part of the town in which these cases have for the most part occurred, namely, Ginns and Newhouses, we are at all times liable to have sporadic cases of enteric fever. The sanitary arrangements, though considered excellent when the town was sewered some thirty years ago, are not in accordance with modern views. The w.c. accommodation especially is not only inadequate, but presents many instances of the 'unfitness of things' referred to in my Annual Report for the year 1900. Frequently the w.c., which is used in common by several houses, is so inconveniently situated that some of the persons using it have to go through parts of several streets or lanes to obtain access to it, whilst in some cases it is possible to enter the w.c.—which is unprovided with light or ventilation—from the kitchen of one house, and to emerge by an alternative door into the kitchen of the next-door neighbour. There is, therefore, all the greater

need for early isolation of cases, and for the adoption of every means to prevent the spread of infection."

The Water Supply in relation to the Outbreak.—The usual characteristics of a water-borne outbreak consist (*a*) in the relative suddenness of the outbreak, (*b*) in the distribution of the cases in the area supplied by the implicated water supply, and (*c*) in the chief incidence of the disease being on the water-drinkers.

In no one of these particulars does a thesis of a water-borne disease receive support in the present instance. The practical limitation of the cases to a certain district is in itself sufficient to negative the view that there has been any contamination of the general water supply of Lake Ennerdale, or of the conduits conveying the water to Whitehaven. Similarly, a view that the outbreak was caused by the specific pollution of a local water main derives no support from a study of the distribution of such mains, and the position of the hydrants.

The Milk supply in relation to the Outbreak.—As has been already pointed out, the milk supply of Whitehaven is largely derived direct from the farms, and a study of the sources from which each of the invaded families obtained their supplies fails to incriminate the milk.

The Consumption of Shell-fish or other Food Stuffs in relation to the Outbreak.—This question has been prominently to the front during this inquiry, but no evidence was procurable which would justify an inference that shell-fish or other foods had been operative for harm. Certain of the families invaded were in the habit of eating mussels, and these mussels were evidently not always prepared in a fashion which would be likely to sterilise any pathogenic organisms which might have been present in them. But while it is impossible to deny that shell-fish may in certain cases have been the source of the disease, there is not sufficient evidence to lead to the conclusion that the outbreak as a whole was due either to shell-fish or to food borne infection.

Occupation in relation to the Outbreak.—The breadwinners of the majority of the families invaded during the outbreak were coal-miners, and I was led to consider how far the fact of their occupation below ground and in the absence of sunlight might have conduced to the spread of the disease. But, as will be seen, there was no special incidence of the fever in the male sex, and if the mines can in any sense have been operative they must have been so through the agency of unrecognised diseases in the case of the miners of the invaded families. I gathered from several miners to whom I spoke that there is no system of excrement disposal in the mines. The artificial ventilation of the mines being what it is, it would seem that theoretically excrement may be afforded an opportunity of drying, and thus being wafted about by the air current; and the absence of sunlight might conduce to a longer survival of the enteric fever bacillus than might otherwise be the case. Still, it has to be accepted that in the present instance occupation seems to have played no prominent part in causation of the fever.

APP. A, No. 15.

On Enteric Fever in Whitehaven and the Sanitary Administration of the Town Council; by Dr. Bulstrode.

The influence of unrecognised cases in relation to the outbreak.—In connection with this question, in addition to the information given me by the Medical Officer of Health, I had the opportunity of conference with Mr. Charles Harris and his brother in whose club practices the majority of the cases occurred. All these gentlemen bore witness to the prevalence during the outbreak, and more particularly in invaded houses, of anomalous cases of illness attended only with a feeling of malaise and some rise of temperature as indicated by the clinical thermometer. Even in several of the cases subsequently recognised and notified by the medical attendant as enteric fever the symptoms seem to have been so vague as to have led to considerable delay in the recognition and consequent notification of the case; indeed in certain instances the patients expressed considerable surprise when the Medical Officer of Health, as the result of the notification, called at the invaded house and informed the patient that removal to hospital would be desirable. The presence of these anomalous cases is obviously in accordance with experience, and assuming due care is exercised no one can be blamed for overlooking them either temporarily or permanently. All that the Medical Officer of Health can ask is that the case shall be notified immediately on its recognition. No arrangements had, at the time of my visit, been made for affording bacteriological assistance to medical practitioners in doubt as to the true nature of any given case.

In the opinion both of the Medical Officer of Health and of the two medical practitioners who attended the majority of the patients, unrecognised cases have contributed materially to the spread of the disease, and the investigations which I was able to make tended towards the same conclusion.

The infectivity of the disease.—There is reason for inferring that the disease in the present outbreak exhibited in particular patients considerable personal infectiveness. But as it is obviously impossible to eliminate the continued or intermittent operation of the cause which may have given rise to the first case in any house where many cases arose, no dogmatic assertion can be made as to this. There are, however, considerations which go far to justify an inference that personal infection has played a prominent part in the present outbreak. The limitation of the cases to a small area in which there must of necessity be constant personal inter-relations of one or another kind, and the insufficiency of a thesis of water, milk, or other food-borne infection to explain this outbreak are facts which of themselves lend some support to a view that personal infection has been largely operative. The number of apparently unrecognised cases, and the anomalous nature of many of the recognised cases also help to sustain this thesis.

There were in all, during the period under review, 55 houses invaded, and there were multiple cases in 13 of such houses, *i.e.*, in one house there were five cases, in two houses there were four cases, in three houses three cases and in seven houses two cases.

Moreover the dates of attack in several instances suggest case to case infection. So, too, an examination of the invaded houses shows that many of them abutted immediately upon one another, or were separated from one another by only one dwelling. In several instances where the infected houses were at a distance from the invaded area the Medical Officer of Health was able to trace direct connection by means of visitors or relatives.

Sex distribution.—Of the 77 notified between May 6th to December 31st, inclusive of that of a nurse who contracted the disease in hospital, 41 were males and 36 females.

Age distribution.—The following table as regard age incidence of the cases shows that, as usual, the age group between 5–15 suffered most.

Age Distribution.	Cases.
0–1	2
1–5	5
5–10	25
10–15	15
15–20	9
20-25	6
25-30	5
30-35	5
35-40	5
40-45	0
45-50	0
TOTAL	77

The fatality rate of the outbreak.—From May 6th to December 31st inclusive there were 77 cases of enteric fever brought to the notice of the Medical Officer of Health, of this number 11 had died at the end of the year, *i.e*, the fatality rate was 14·3 per cent. Of the total 11 deaths 9 died in hospital and 2 at home.

Precautions taken to control the outbreak.—Upon the receipt of a notification it is the routine practice of the Inspector of Nuisances to forthwith visit the invaded house, and to make inquiries with respect to infection. If the case is to be removed he supervises the removal, if it is to be isolated at home he gives instructions as to disinfection.

The Inspector of Nuisances had, in the outbreak under consideration, arranged that certain closets should be set apart for the enteric fever excreta, and the drains and sewers of the invaded area were, he reported, repeatedly flushed.

When the case is removed to hospital the bedding and clothing is taken to the disinfector to be disinfected, and the room fumigated with sulphur dioxide.

Bedding does not appear to have been removed in the past as a matter of routine in cases of enteric fever, and such removal has been governed rather by the obvious soiling or not of the bedding. But seeing that the urine, as well as the excreta, is liable to contain the bacillus of enteric fever, it would, I think, be well that disinfection should be carried out in all cases, and I believe that this practice will now be adopted. With regard to the details of disinfection I made some suggestions to the officers concerned as to the amount of sulphur which should be used where that agent is employed, and I also advocated more use being made of the statutory powers possessed by the sanitary authority for enforcing the cleansing of invaded houses.

The sanitary authority are, I think, to be commended for the promptitude with which, on the recommendation of their Medical Officer of Health, they erected the temporary hospital building to which reference has been made. By this means they have done much to limit the spread of the disease. I was much impressed during my visits to the invaded houses of the impracticability of enforcing proper isolation in the houses of the poor. In certain cases the patient appears to have slept with one of his or her parents during the whole period of the illness, more particularly in cases when such illness was of a somewhat anomalous nature. In other instances there seemed to have been difficulty, so little unwell was the patient, to confine him or her to bed for more than a few days, and there is to my mind little doubt that this difficulty of control played a not unimportant part in the prevalence and maintenance of the outbreak. I suggested to the Medical Officer of Health that it might assist matters if he had drawn up leaflets embodying suggestions in simple language as to the precautions to be taken in connection with cases which were not removed to hospital, and I learn from him that this suggestion has now been acted upon.

The Surveyor and the Inspector of Nuisances have been active in relation to the examination of the drainage in the invaded houses. Numerous defects of a serious nature have been found in many instances and such defects have now been remedied.

General Sanitary Administration of the Borough Council.—The Medical Officer of Health is Mr. John Bell Fisher, M.B., C.M., Edin., 1880. He receives a salary of £75 per annum for his part time service as Medical Officer of Health, and £50 a year in his capacity as Medical Superintendent to the Isolation Hospital: he is also Medical Officer of Health to the Whitehaven Rural District. Dr. Fisher possesses no diploma in public health, but he has held his present appointment since 1888.

APP. A, No. 15.

On Enteric Fever in Whitehaven and the Sanitary Administration of the Town Council; by Dr. Bulstrode.

The Borough Engineer and Surveyor is Mr. Ernest E. Stiven who has under him an assistant surveyor, a clerk, a sewerage foreman, a waterworks foreman with six men, a street foreman, and a foreman scavenger, this latter having charge of some 20 scavengers.

The Inspector of Nuisances is Mr. Daniel William Pearson who receives £100 per annum for his whole time services. This Officer possesses no certificate in sanitary science, but he seemed to me to be a conscientious and tactful officer.

Sanitary Administration of the Town Council.—There is undoubtedly much good work standing to the credit of the present sanitary authority and to that of those who have preceded it in office. Notably may be mentioned the abolition of the old privies and the substitution of water closets. The condition of the courts and alleys at the time when privies obtained must have been eminently insanitary, and bad as is the existing condition of affairs it is a considerable improvement upon the past. A large number of water closets have been erected during the last two years, and their number is daily increasing. So, too, there has been increase in the number of standpipes for water, but they are still too few.

The paving of numerous courts and alleys, and the lighting thereof by artificial light must have been a great boon to the dwellers in these localities.

The Isolation Hospital is a satisfactory building. During the course of my inspection several of those who had been patients, or who had had relatives at the hospital, spoke appreciatively of the treatment and care which they or their relatives had received. Quite recently the Corporation has taken over the Public Baths from a Company, and considerable improvements in them are to be made.

But the record of the Council's doings in the matter of the housing of the poorer classes has not been an illustrious one, and this report will have served a useful purpose if it proves instrumental in persuading them to let light and air into some of the worst alleys and courts of the borough, and generally to pay more attention to the subject of ventilation and light. In many cases the windows of the poorer dwellings could not be opened.

The council should also turn their attention to improving the condition of the common lodging houses, of the slaughter houses, cowsheds, &c., and they should by means of a sub-committee appointed to inspect these places ascertain that the byelaws and statutes in force with regard to them are duly observed.

The work of improving the drainage of the poorer property should be pushed forward.

The council should bear in mind that outbreaks of enteric fever and of typhus fever can be prevented by improving the sanitary state of the poorer parts of the town and by bettering the conditions under which the poor are living.

These localised outbreaks are evidence under the present circumstances that an enormous amount remains to be done, and

the council would do well to turn their attention in the first instances to "Newhouses" and "Ginns," to Mount Pleasant where the 1884 outbreak occurred, and also to the area which was the scene of the outbreak of typhus fever. This latter disease is now unknown in England save in association with the most faulty conditions of environment.

ADDENDUM.

The County Analyst's Laboratory,
Whitehaven,
July 27th, 1901.

DEAR SIR,

I ENCLOSE herewith the results of the analysis of the samples of water taken on 5th inst. from the tap in Dr. Ablett's house in Roper Street.

The first sample represents the water which was standing in the house pipes at the time the sample was taken, no water having been run off from the tap before it was collected. The second sample was not collected until the water had run for several minutes, sufficiently long to empty the pipe between the pipe and the street main. It therefore represents the water which was in Roper Street main at 1 p.m. on 5th inst. The object of taking the two samples was to ascertain whether there was any source of pollution in the house pipes of 30, Roper Street.

The analyses of these two samples are identical. The water supplied to Dr. Ablett is, therefore, the same as that supplied to other houses in Roper Street.

On comparing these analyses of Whitehaven water with some I have made on previous occasions, I find that there is no practical difference. Ennerdale water has, therefore, not deteriorated. The point to which my special attention was asked is the smell, which, I think, is distinctly more appreciable at present than is usual. To me it recalls the smell of the lakes in summer, and is very likely due to vegetable matter in the water. The cause of its being more pronounced now is probably the long spell of hot weather which we have had recently, and which, by reducing the amount of water flowing into the lake, would concentrate the vegetable matter into a smaller volume of water. That this concentration has not proceeded very far is shown by the fact that it has not produced any appreciable effect upon the chemical analysis; and since the chemical analysis shows that ours is one of the purest water supplies in the kingdom, we are very far from the point of danger.

In addition to the chemical analysis, I have submitted the two samples of water to a bacteriological examination, and have found 13 bacteria per cubic centimeter in the first sample, and 18 bacteria per cubic centimeter in the second. None of these bacteria were pathogenic.

Since it has been proposed that a water containing less than 100 bacteria per cubic centimeter should be classed as pure, it is evident that the bacteriological examination quite confirms the high opinion which I have already expressed of the quality of the Whitehaven water supply.

I am, dear Sir,
Yours faithfully,
(Signed) ROBERT HELLON.

T. Brown, Esq.,
Town Clerk,
Whitehaven.

The County Analyst's Laboratory
Whitehaven,
July 27th, 1901.

Dear Sir,

I beg to inform you that the following is the result of my analysis of the sample of water taken at Dr. Ablett's house on 5th inst., marked "No. 1":—

	Grains.
Total solid matter in solution dried at 212° Fahr. ...	1·400 per gallon.
Chlorine existing as chlorides	·560 "
Ammonia	trace "
Albuminoid ammonia	·002 "
Nitrogen existing as nitrates	trace "
Oxygen absorbed in 15 minutes at 80° Fahr.	·011 "
Oxygen absorbed in four hours at 80° Fahr.	·020 "
Lead and other poisonous metals	none.
Hardness before boiling	1·2 degrees.
Hardness after boiling	·8 "
Appearance in 2-ft. tube	turbid, faint green.
Smell when heated to 100° Fahr....	faint.

Microscopical examination—vegetable debris and diatoms.

I am, dear Sir,
Yours faithfully,
(Signed) R. HELLON.

T. Brown, Esq.,
Town Clerk,
Whitehaven.

The County Analyst's Laboratory,
Whitehaven,
July 27th, 1901.

Dear Sir,

I beg to inform you that the following is the result of my analysis of the sample of water taken at Dr. Ablett's house on 5th inst., marked "No. 2":—

	Grains.
Total solid matter in solution dried at 212° Fahr. ...	1·400 per gallon.
Chlorine existing as chlorides	·560 "
Ammonia	trace "
Albuminoid ammonia	·002 "
Nitrogen existing as nitrates	trace "
Oxygen absorbed in 15 minutes at 80° Fahr.	·011 "
Oxygen absorbed in four hours at 80° Fahr.	·020 "
Lead and other poisonous metals	none. "
Hardness before boiling	1·2 degrees.
Hardness after boiling	·8 "
Appearance in 2-ft. tube	turbid, faint green.
Smell when heated to 100° Fahr.	faint.

Microscopical examination—vegetable debris and diatoms.

I am, dear Sir,
Yours faithfully,
(Signed) R. HELLON.

T. Brown, Esq.,
Town Clerk,
Whitehaven.

No. 16.

App. A, No. 16.

On the Sanitary Circumstances of Fishguard and Goodwick in relation with prevalence of Diphtheria; by Dr. Wheaton.

REPORT on the SANITARY CIRCUMSTANCES of FISHGUARD and GOODWICK, in the HAVERFORDWEST RURAL DISTRICT with special reference to the RECENT PREVALENCE of DIPHTHERIA in those places; by DR. S. W. WHEATON.

For some years past the annual reports of the Medical Officer of Health of the Fishguard division of the Haverfordwest Rural District have contained references to unwholesome conditions existing in the town of Fishguard and the village of Goodwick, especially in the case of the latter place, where it was reported that there was no sewerage provision, and that nuisances were very prevalent. Correspondence with the Rural District Council failed to elicit any evidence of measures taken for removing the insanitary conditions reported by the Medical Officer of Health. In 1899, the prevalence of diphtheria at Fishguard was notified to the Board, and a special report on the circumstances of the outbreak was called for, and furnished to the Board by the Medical Officer of Health, Mr. Morgan Owen. This report showed that very little was being done at the instance of the Rural District Council to check the spread of the malady; that there was no provision for isolation of cases of the disease which could not be treated at home with safety to others; and that there was no efficient disinfection of infected bedding and clothing. Early in 1901, the prevalence of diphtheria in the adjoining village of Goodwick was reported to the Board.

Under these circumstances, I was instructed to visit the two places, and report upon their sanitary circumstances, and on the prevalence of diphtheria.

The Haverfordwest Rural District, in the County of Pembroke, has an area of 169,810 acres, and had, in 1891, a population of 22,281 persons. In 1901, the population comprised 22,032 persons, a decrease of 249 in the intercensal period. For the purposes of Public Health Administration, the District is divided into four divisions, each of which has a separate Medical Officer of Health, who in each case is also a District Medical Officer. These divisions are named respectively, (1) Fishguard, in which are situate the two places under notice, and which had in 1891 a population of 6,955 persons; (2) Milford; population in 1891, 5,639; (3) St. David's; population in 1891, 5,803; and (4) Haverfordwest; population in 1891, 4,082. There is, however, only one Inspector of Nuisances for the whole Rural District.

Diphtheria in the Fishguard division has been almost entirely confined in its prevalence to the two contiguous parishes of Fishguard and Llanwnda, in the latter of which the village of Goodwick is situated. The major part of the population of the parish of Llanwnda reside in the village of Goodwick. Goodwick and Fishguard are only one mile apart, they are the most populous and important placas in the division, and the inhabitants are in constant communication. Both are on the sea coast and have harbours. The population of Fishguard in 1891 was 1,898 persons;

in 1901, according to information given me by the Clerk to the Rural District Council, it was 1,992, an increase of 94. The population of Llanwnda parish in 1891 was 918; at the last census it was 1,110, an increase of 192 persons. Thus it is evident that, the population of these two parishes has increased whilst that of the Rural District taken as a whole has diminished. The increase of population in these two parishes is explained by the development of a new harbour at Goodwick in connection with the Great Western Railway and the opening of a line of railway to the place from Glynderwen station on the Great Western main line. In consequence of the harbour works at Goodwick the value of property in the place has increased, a hotel has been opened there by the Great Western Company, and a number of small villas and cottages have been erected.

The Sanitary Condition of Fishguard.—This town is built for the most part on high ground overlooking a harbour which is almost land-locked, the natural drainage flow is towards the harbour.

Dwellings are for the most part well built of stone with sufficient surrounding air space, but in the older part of the town there is a collection of dwellings without curtilage and without back doors or windows in the rear.

The town was partly sewered in 1876, but no outfall sewer was constructed. The sewage escapes from several sewers in the upper part of the town and runs down a sloping piece of waste ground in the channel of a small watercourse and falling into the harbour produces much nuisance by accumulating on the foreshore. The effect of the tide in removing it is almost *nil* owing to the land-locked character of the harbour. At the harbour a number of dwellings, which are detached from the town, are connected to a sewer which terminates in an iron outfall pipe at the entrance to the harbour, at a point between high and low water mark. This sewer has, however, become blocked, and no sewage escapes from the outfall. The sewers are of glazed earthenware pipe, and rubble. A considerable number of dwellings are not connected to the sewers.

In the case of many dwellings which are without house drains, liquid refuse is thrown on the ground, in the streets, or into the street gulleys in connection with the highway drains.

Excrement disposal is chiefly effected by means of pail privies. These are often greatly neglected and very filthy, owing to the carelessness of the inhabitants. The contents of the pails are allowed to overflow and accumulate on the floor, and when removed are frequently thrown over a wall, or on the piece of waste ground before mentioned as traversed by the sewage of the town on its way to the harbour. This piece of ground is partly surrounded by houses, and is a source of great nuisance. A number of dwellings in the town have no privies; the inhabitants use pails inside the houses, the contents being thrown down in the nearest available place since they have no garden ground.

Water is supplied from a number of wells, springs, and road-side spouts. Some of these sources are so circumstanced that there is risk of the water furnished by them being fouled by collections of filth in their neighbourhood, especially in the case of springs and wells, and from drains and sewers in their vicinity. The Fishguard Water Company have obtained powers to supply this place and Goodwick, but have not furnished any supply up to the present.

There is a large slaughter-house belonging to a company at the market, at which a number of butchers slaughter. There were formerly many complaints of nuisance from it, but it appears now to be better managed.

Nuisances are very rife throughout the town, especially those arising from accumulations of manure from pigs and other animals, from accumulations of refuse, and from neglected and filthy privies.

Sanitary Circumstances of Goodwick.—The village of Goodwick is situate on the side of a steep hill, sloping for half of its extent towards the sea, and for the remainder of its extent sloping towards a marsh which drains into the sea. Hence, half the village was formerly drained directly to the sea, the remainder draining towards the marsh. The construction of the harbour has prevented the direct access of the tides which formerly removed the filth escaping on the foreshore from those dwellings fronting the sea, and has thus increased any nuisance which formerly was caused in this way. The engineer in charge of the harbour works informed me that a sewer would be shortly constructed by the Great Western Railway Company, which has recently acquired the undertaking of the Harbour Company, to drain those houses whose sewage outfalls had been thus interfered with.

Dwellings in the village are for the most part well built, but there are a number of old small cottages which have no back windows, owing to the steepness of the land in their rear. At an outlying hamlet also, Dyffryn, there are a number of small cottages without back windows or through ventilation. There are also some newly-built dwellings, shops, small villas, and cottages; and others are in course of construction. Large stables and a steam laundry have also been constructed by the Railway Company, as also a number of huts for navvies.

Water supply is obtained from a number of dip wells, springs, and spouts conveying water draining from the hill. A large number of dwellings formerly obtained their supply from a dip well, known as the Kiln Well, which was thought to furnish water superior in quality to the other supplies. This well has, however, been disturbed by the construction of a new railway embankment, which has, by its weight, forced up the peat of the marsh, and thus fouled the water by decaying vegetable matter. Nothing has been done by the Rural District Council to protect these various supplies from chance contamination, or to store the water furnished so that it might be available in times of drought. In dry weather many persons have to go a long distance, ¼ of a mile

or more, for water; and many persons who formerly used the Kiln Well now give one day's work per annum in the hayfield in return for permission to take water from a private supply; others pay a small sum yearly for the same privilege.

There are no sewers in the village. As before-mentioned, one will shortly be constructed by the Railway Company to take the liquid refuse from dwellings, the sewage from which was formerly discharged on the foreshore.

A few dwellings have drains connected to cesspools, but the majority have none. Liquid refuse is thrown on the road-side, or over a wall, or down the side of a bank. Great nuisance arises in various parts of the village from stagnant accumulations of liquid refuse.

Excrement disposal is effected by pail privies, midden privies, and water-closets; but a large proportion of the dwellings have no privies, the excrement being collected in pails inside dwellings and thrown on waste ground, or, as with liquid refuse, over a wall, in the absence of garden ground. The contents of pail privies are, where possible, buried in gardens, but in instances where there are no gardens the filth, as before-mentioned, is got rid of by throwing it over a wall, or down the side of the cliff.

Midden privies are uncovered, the middens in some instances are merely holes in the ground, the contents are generally used as manure for gardens. There are a few water-closets in use in houses of a superior class, these are supplied with water from tanks on the hill-side, from which water is piped to the dwellings.

Nuisances abound in the village, arising from collections of house refuse, manure from animals, undrained pig-sties, collections of stagnant sewage from dwellings, and badly-constructed and over-full privies. When urged by the Board to provide sewers for the village the Rural District Council have replied that there is no water supply available for flushing them. The medical officer, however, has expressed the contrary opinion; and I should say from my own observation that water at present running to waste from various springs on the hill-side could be collected in tanks and used for the flushing of sewers. The huts for navvies, belonging to the railway company, are at present drained into a ditch running by the side of the road, producing great nuisance from the decomposition of the sewage, which remains almost stagnant in the ditch. The contents of pail-closets from these huts are thrown into an open uncovered midden, thus causing much nuisance. I was informed that the railway company are about to build a further number of huts of similar type.

Prevalence of Diphtheria in Fishguard and Goodwick.—There were no deaths returned from diphtheria in the Fishguard division in 1897 and 1898, but one death was certified as due to membranous croup in each of these years. In 1899, however, diphtheria broke out early in the year at Fishguard among children attending the National Schools. From Fishguard it soon spread to Goodwick in Llanwnda parish, and in that year at least 40 diphtheria attacks were notified in these two parishes. Five deaths from diphtheria

APP. A, No. 16.

On the Sanitary Circumstances of Fishguard and Goodwick in relation with prevalence of Diphtheria; by Dr. Wheaton.

occurred in 1899 in each parish, *i.e.*, 10 deaths out of a total of over 40 cases. The Medical Officer of Health attributes the origin of the outbreak to the unwholesome condition of the National Schools at Fishguard. He had observed for a year or more previous to the outbreak that "sore throat" was very prevalent among the children attending these schools and that many complaints were received by him of foul smells in the schools. When the outbreak occurred the drains of the schools were examined, and found to be blocked and broken, so that sewage had accumulated for some years, and the subsoil around the schools was "sodden with filth."

In 1900 diphtheria continued to be prevalent in these two places, and during the year 43 attacks were notified in the parishes of Fishguard and Llanwnda with, however, only two deaths, one in each parish. During the present year, 1901, up to the time of my visit at least six attacks have been notified in Llanwnda parish and one in Fishguard, but no deaths appear to have occurred in this period.

The information to be obtained as to the prevalence of the disease is very scanty and unreliable, since no register has been kept of the certificates received under the Infectious Disease Notification Act, and all the certificates have been destroyed, even those most recently received. The Medical Officer of Health states that he receives the return of deaths in his district from the local Registrar only once in each year, and that the list is not received until the end of the first quarter in the year following that to which it relates. The certificates under the Infectious Disease Notification Act of 1889 are forwarded by the Medical Officer of Health to the Clerk to the Rural District Council who hands them to the Inspector of Nuisances, who then destroys them without keeping any record of the particulars contained in them. Hence nothing can be said as to the incidence of diphtheria in Fishguard and Goodwick—whether this was influenced by season of the year or otherwise, or what were the ages of the sufferers, their sex, and social condition.

Measures taken for preventing the spread of Diphtheria.—With respect to diphtheria the Rural District Council have taken no action for preventing the spread of the disease, with the exception that the schools at Fishguard were closed for three weeks on one occasion, and certain scholars have been excluded from attendance at school at Goodwick. There has been no hospital isolation of sufferers from diphtheria, the Rural District Council having made no provision for this purpose. There has been no disinfection of bedding, clothing, or dwellings by the officers under the direction of the Rural District Council, which possess no disinfecting apparatus. There have been no legal proceedings taken for the abatement of a nuisance in the district for many years past So far as I could ascertain the Rural District Council, beyond giving instructions for the alteration or improvement of some offensive privies, have taken no action for improving the sanitary condition of Fishguard and Goodwick.

Sanitary Administration of the Rural District Council.—The Medical Officer of Health for the Fishguard Division is

Mr. J. Morgan Owen, of Fishguard, who receives £20 per annum for his services.

The Inspector of Nuisances is Mr. J. W. Francis, whose salary is £100 per annum, and he also receives £50 as examiner of plans of new buildings.

The Rural District is very extensive, the means of communication are almost entirely by roads, which are often very hilly. The different portions of the district are consequently, to a great extent, isolated from one another, the inhabitants tending to go to the nearest market town or railway station, which is probably not situated in the district. The different members of the District Council, therefore, can hardly take much interest in places which they have never seen, and are not likely ever to visit. The respective Medical Officers of Health for the four districts do not attend the meetings of the Council, except under very exceptional circumstances. In fact, the salary received in some instances would not pay their travelling expenses in attending the meetings, and recoup them for the loss which might occur in their private practice during their absence.

The Medical Officers of Health know nothing of one another's districts, hence no comprehensive advice as to sanitary improvements can be given by them to the District Council. The only person having any general knowledge of the sanitary requirements of the district is the Inspector of Nuisances. This officer is very desirous of carrying out his duties in the most efficient manner, but unfortunately he is unable to make any severe exertion owing to physical infirmity, and the work of effectually supervising such a large area as that under his charge would tax the energies of the most vigorous individual. The Inspector of Nuisances has very little time to spare for clerical work; hence he does not keep any journal or report book. He reports to the Council every month on the matters which are most pressing, and receives their instructions before taking any proceedings respecting nuisances.

The District Council have byelaws for slaughter-houses which were allowed by the Board in 1899. They have also byelaws for new streets and buildings which were allowed by the Board in the same year. In both instances the byelaws are limited in their action to the contributory places of Fishguard, Hulberston, Letterston, Llanwnda, St. David's, Steynton, Talbenny, and Walton West. There are also regulations for dairies, cowsheds, and milkshops.

Recommendations.

With a view to the prevention of outbreaks of infectious disease in the future—

(1) The Rural District Council should carry out their duties as a Sanitary Authority under the Public Health Acts, by the neglect of which they have incurred a serious responsibility.

(2) Accommodation should be provided for the isolation of sufferers from infectious illness, so that by the prompt removal of persons suffering from infectious disease, who cannot be cared for at their own homes without risk of the spreading of infection to others, outbreaks of infectious illness may be cut short at their onset.

An efficient apparatus should also be provided for the disinfection of infected bedding and clothing.

(3) The sewerage of Fishguard should receive attention. An outfall sewer should be constructed to take the sewerage out to sea, so as to avoid nuisance, and the existing sewers should be examined to see if they are efficient. All dwellings in the town should be provided with house drains and connected with the sewers. At Goodwick sewers should be constructed.

(4) The provision of privy accommodation for all dwellings should be enforced. Where occupiers have no garden ground available for the disposal of the contents of privies, the Rural District Council should arrange for their cleansing at regular intervals and for the removal of their contents without causing nuisance.

(5) Greater activity should be shown in the detection and prevention of nuisances. With this object the Inspector of Nuisances should be provided with an assistant.

(6) With a view to the more efficient carrying out of the Public Health Acts one Medical Officer of Health should be appointed for the whole Rural District, so that he will be able to advise the District Council as to the measures which are necessary to be taken for the improvement of the sanitary condition of the district as a whole.

No. 17.

MEMORANDA PREPARED by the MEDICAL OFFICER and CIRCULARS ISSUED by the LOCAL GOVERNMENT BOARD in 1901 relating to PUBLIC HEALTH and VACCINATION.

A. MEMORANDA :—

(1.) Ship-borne Rats and Plague. (April, 1901.)

(2.) Memorandum on the steps specially requisite to be taken in places where Small-pox is prevalent. (Provincial, March, 1901.)

(3.) Memorandum on the steps specially requisite to be taken in places where Small-pox is prevalent. (London, September, 1901.)

(4.) Memorandum on the circumstances under which the Closing of Public Elementary Schools, or the Exclusion therefrom of particular Children, may be required in order to prevent the Spread of Disease. (September, 1901.)

B. CIRCULARS :—

(1.) Ship-borne rats and plague. (29th April, 1901.)

(2.) Tuberculosis. (6th September, 1901.)

(3.) Isolation Hospitals Act, 1901. (6th September, 1901.)

(4.) The Vaccination Acts, 1867 to 1898. (17th September, 1901.)

(5.) Small-pox in the Metropolis: Vaccination and Re-vaccination. To Boards of Guardians. (25th September, 1901.)

(6.) Small-pox in the Metropolis. To Metropolitan Borough Councils. (25th September, 1901.)

(7.) Small-pox. To Guardians in the Home Counties. (6th December, 1901.)

(8.) Small-pox hospital provision. To Councils of Boroughs or other Districts in Home Counties. (6th December, 1901.)

(9.) Notification of Chicken-pox and Re-vaccination of Sanitary Staff. To Metropolitan Borough Councils. (27th December, 1901.)

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Memoranda and Circulars issued in 1901.

A.

(No. 1.)

SHIP-BORNE RATS AND PLAGUE.

In view of the susceptibility of the rat to Plague, and of risk therefore of importation into this country by shipping of plague-infected rats, Sanitary Authorities of seaports should be on the alert to prevent introduction of the disease into their districts in this way.

1. On the arrival in port of a vessel whereon, during the voyage, Plague or sickness suspected to be Plague has occurred, measures should be taken to secure the destruction of the rats on board the vessel. Until this has been done, endeavour should be made to prevent rats leaving the ship, by mooring the vessel a sufficient distance from other ships and from the shore, and by placing guards on cables and hawsers in use for mooring purposes.

2. In the case of vessels that have come from places infected with Plague, but on board of which no Plague or suspected Plague has occurred, strict inquiry should be made on their arrival in port as to mortality or sickness among rats during the voyage. Should this have occurred, the Authority would do well to obtain the body of a sick rat for the purpose of ascertaining the nature of the malady affecting those animals on board the vessel In the event of the malady being found to be Plague, the ship should be dealt with as under Paragraph 1.

3. Exceptional sickness or mortality among rats on board any vessel within the district, whatever may have been her port of departure, should be viewed with suspicion and as giving occasion for action similar to that indicated under Paragraph 2.

4. Rats when destroyed on shipboard should not be handled: they should be at once cremated.

5. In the event of rats on board any ship being found to be infected with Plague, all parts of the vessel frequented by those animals should, as far as possible, be disinfected.

6. The Authorities of seaport towns invaded by Plague should endeavour to secure the destruction of the rats of the town, not least those inhabiting the docks and quayside warehouses. Measures should be taken to guard against shore-rats making their way on board vessels lying in the port, and attempt made to destroy all rats on board ships about to proceed on their voyage. Captains of such vessels should be urged to take steps during the ensuing voyage for the destruction of rats that may have remained alive on board their vessels notwithstanding the action of the Local Authority.

W. H. POWER,
Medical Officer.

Local Government Board,
Medical Department,
April, 1901.

(No. 2.)

PROVINCIAL.

MEMORANDUM ON THE STEPS SPECIALLY REQUISITE TO BE TAKEN IN PLACES WHERE SMALL-POX IS PREVALENT.

I.—BY BOARDS OF GUARDIANS.

As it is by vaccination that the spread of small-pox can most effectually be prevented, Boards of Guardians, as soon as any case of that disease is brought into or occurs in their respective unions or parishes, should see that measures are promptly taken to secure, as far as is necessary and practicable under the law relating to vaccination, the vaccination (or, as the case may be, re-vaccination) of all such persons as are especially exposed to the danger of the infection.

Under sect. 7 of the Vaccination Act, 1898 (61 *and* 62 *Vict. c.* 49), *the Local Government Board may by Order, if in their opinion it is expedient by reason of serious risk of outbreak of small-pox, or of other exceptional circumstances, require any Board of Guardians to provide vaccination stations for the vaccination of children with glycerinated calf lymph, or such other lymph as may be issued by the Board, and modify as respects the area to which the Order applies, and during the period for which it is in force, the provisions of that Act requiring the public vaccinator to visit the home of the child, otherwise than on request of the parent; and it will be for Boards of Guardians to make application to the Local Government Board for the issue of such an Order whenever local circumstances appear to them to demand the exercise of the power conferred on the Board by the section in question. It is also provided under sect.* 13 *of the Vaccination Act,* 1871 (34 *and* 35 *Vict. c.* 98), *that District Medical Officers in attendance upon any person suffering from small-pox shall be entitled to payment from the Guardians for vaccinating or (as the case may be) re-vaccinating any person who is resident in the same house as the sick person, and who could lawfully be vaccinated or (as the case may be) re-vaccinated by a Public Vaccinator at the public expense.*

These provisions, promptly applied in the event of serious risk of an outbreak of small-pox, will in general be found adequate to stop the spread of the disease; but if from neglect of them, or from any other circumstance, cases of small-pox spread in the district, special measures should be taken to expedite, as far as practicable, the vaccination of all unvaccinated persons in the district and to promote the re-vaccination of adults and adolescents who have not already been successfully re-vaccinated.

In order that speedy discovery may be made of all unvaccinated persons, whether born in the district, or newly arrived there, it will frequently be desirable that some temporary assistance be given to Vaccination Officers, in the manner provided in Article 10 (2) *of the Vaccination Order,* 1898.

This Memorandum is intended to afford information on the measures and arrangements referred to above.

A.—Special Instructions to Vaccination Officers.

1. On the occurrence of any prevalence of small-pox the Vaccination Officer should give his first and special attention to the particular localities in which the infection exists.

2. In order that for this purpose he may have the earliest possible information of the occurrence of cases of the disease, the Guardians should invite the Medical Officer of Health to give information to the Vaccination Officer of each case of small-pox as soon as it is notified, and, with the same object, the co-operation of persons who visit among the poor should be secured. They should also instruct their District Medical Officers to give the Vaccination Officer immediate notice of every fresh case of small-pox which comes under their care, and arrange with the Registrars of Deaths to forward to him immediate notice of each death registered from small-pox. For convenience of transmitting such notices, each District Medical Officer and Registrar should be supplied with forms duly stamped for post, or with post-cards adapted for the purpose. Private medical practitioners may be invited to give similar information.

3. In each locality in which the infection exists, the Vaccination Officer should, with the utmost possible dispatch, personally ascertain what children are unprotected by vaccination, and should use his utmost exertions to obtain the prompt vaccination of all such children. Generally speaking, his own judgment and local knowledge will guide him as to the manner in which his inquiries can best be made; but in infected courts or alleys, as well as in certain kinds of streets, inquiries from house to house, and, in tenement houses, from room to room, will be indispensable.

4. Where any child (between the ages of six months and 14 years) who has not already had small-pox, or has not been duly certified as insusceptible of vaccination, or has not come within the terms of exemption under section 2 of the Vaccination Act, 1898, or whose vaccination is not at the time standing postponed under medical certificate, is found to be unvaccinated, the Vaccination Officer should take steps to procure the vaccination of the child with all practicable speed.

With regard to unvaccinated children, not yet six months old, who may be in infected localities, the Vaccination Officer should advise the parents not to incur the unnecessary risk of waiting for the child to reach that age before having its vaccination performed. In no house in which there is small-pox ought any child to remain unvaccinated, unless on medical examination it is pronounced unfit to be vaccinated.

5. All representations made as above should be accompanied with information as to the existing arrangements for vaccination, including any special temporary provisions which may have been made under section 7 of the Vaccination Act, 1898, for Public Vaccination in the district.

6. The Vaccination Officer should make it well known that the Public Vaccinator is at liberty to re-vaccinate all persons who shall not be less than ten years old and shall not have been previously re-vaccinated within a period of ten years, who apply to him for that purpose; and that persons not vaccinated since childhood, who are likely to be exposed to contagion, ought to be re-vaccinated without delay. Above all, this is necessary for persons whose original marks of vaccination are imperfect.

7. In the event of many artizans requiring re-vaccination, and being unwilling to lose part of their working day for the purpose of securing the desired protection, it may be expedient that the Vaccination Officer should confer with the Guardians as to attendances being given by the Public Vaccinator at some specified hour in the evening.

8. Generally, the Vaccination Officer should take every means to ensure that the vaccination of his whole district is as complete as possible. He should make frequent examination of his birth-lists; and deal, as soon as practicable, with every case of default as it arises; and he should be prompt and diligent in his inquiries respecting the other children to whom his duties extend under Section 7 of his "Instructions," as issued by the Local Government Board.

9. The Vaccination Officer should gives immediate information to the local Sanitary Authority of any house in which small-pox has appeared, and of which no information has reached him from the Medical Officer of Health, in order that needful means of isolation and disinfection may be taken.

II.—BY SANITARY AUTHORITIES.

The Sanitary Authority of any district into which a case of small-pox may be brought, or in which it may occur, should immediately, on obtaining information of the occurrence, instruct their Medical Officer of Health to give notice to the Vaccination Officer of the Board of Guardians (the Local Authority for vaccination purposes), in order that all practicable measures in regard to vaccination may be taken. The Sanitary Authority should also instruct their officers to assist in the administration of the Vaccination Acts by spreading a knowledge of the advantages of vaccination and re-vaccination, and by giving to the Vaccination Officer any information they may obtain as to children and others unprotected by vaccination.

The Sanitary Authority themselves should, on any appearance of small-pox within their district, at once proceed (under the powers of the Public Health Act, 1875) *to see that proper means to prevent the spread of the disease by ISOLATION OF THE SICK AND BY DISINFECTION OF INFECTED HOUSES AND THINGS, are adopted. Any extension of the disease from the house first infected, or any fresh importation of it, needs to be dealt with in the same way. And as, from the extreme infectiousness of small-pox, every new case is a fresh source of danger, it is of the first importance towards preventing the spread of the disease that the necessary measures of the kind above-mentioned should be taken in each case at the earliest possible moment. Hence it is important for every Sanitary Authority to see that their Medical Officer of Health is kept informed, as completely and promptly as possible, of all cases of small-pox occurring in the district. The knowledge thus obtained should be supplemented by information procured by house to house inquiry in each locality invaded as to cases of modified small-pox that may have escaped recognition or treatment, and by immediate notice from the District Registrars of all deaths from small-pox.*

In any district invaded by small-pox the Sanitary Authority will find especial advantage in possessing powers under the Infectious Disease (Prevention) Act, 1890.*

The following are the measures which Sanitary Authorities should take for the attainment of these objects:—

1. It is of great importance that all persons suffering from small-pox, and so lodged that the isolation of them from healthy persons cannot be secured without their removal, should be removed to some special hospital or place for the reception of the sick. The 124th Section of the Public Health Act, 1875, in the cases before mentioned, gives power to a Justice to order such removal†; and resort should be had to this provision wherever such a measure seems necessary to prevent the spread of the disease. Similar powers for the necessary detention in hospital of persons suffering from infectious disease are obtainable under the 12th Section of the Infectious Disease (Prevention) Act, 1890. The 91st Section of the Public Health Act, 1875, including within the term "nuisance" such overcrowding of a house or any part of a house as is dangerous or injurious to the health of the inmates, should also receive the special attention of the Sanitary Authority wherever any infectious disease is or threatens to become prevalent in the district; and the powers given in the 142nd Section of the Act of 1875, as well as those obtainable under Sections 8, 9, and 10 of the above-named Act of 1890, should, if necessary, be exercised with regard to the bodies of persons who die of small-pox.

2. If it be doubtful weather suitable accommodation will be found in existing hospitals for the cases of small-pox in the district which ought to be removed from their homes, the Sanitary Authority, who (under Section 131 of the Public Health Act) have power to provide any requisite accommodation for such cases, should bear in mind that small-pox hospitals, as we know them, are apt to disseminate small-pox, and that their sites, therefore, should be placed outside of towns, and should indeed be sought at places as far distant from any populated neighbourhood as considerations of accessibility permit.

3. It is equally necessary that all houses or rooms and things infected with small-pox should be disinfected under skilled direction, and with as little delay as possible after the removal, convalescence, or death of the patient, and for this provision is made in Section 120 of the Public Health Act, 1875, and more fully in Sections 5, 6, and 7 of the Infectious Disease (Prevention) Act, 1890. To secure the disinfection of houses or rooms being properly preformed it will be desirable that it should, in as many cases as possible, be done by the servants of the Sanitary Authority, and to the satisfaction of the Medical Officer of Health. Under the 15th Section of the Infectious Disease (Prevention) Act, 1890, temporary shelter or house accommodation may be provided for the members of any family in which infectious disease has appeared, and who are compelled to leave there dwellings for the purpose of enabling such dwellings to be disinfected by the Sanitary Authority. In order that infected articles and things may be readily but sufficiently disinfected, it will be necessary that a place with the requisite apparatus and attendance for disinfection (preferably by steam) be ready for use (Public Health Act, 1875, Section 122). If these public means of disinfecting infected articles and things have not already been provided, this should at once be done. Often it will be better, instead of disinfecting infected articles (such as bedding and clothing), to destroy them; and the Sanitary Authority have power, under Section 121 of the Public Health Act, 1875, to do this, and to make compensation for the articles destroyed.

4. As infectious diseases may be spread by the use of public carriages for the conveyance of the sick and of convalescents, the Sanitary Authority should

* This Act may be adopted at the option of Sanitary Authorities. But it is to be remembered that at least 14 clear days' notice of the proposed resolution to adopt the Act must be given to every member of the Authority: Also that the resolution adopting the Act must be locally advertised at least a month before it can come into force. It is important therefore that adoption of this Act be not deferred until infectious disease is actually epidemic in the district.

† In the case of *Warwick* v. *Graham* L.R. [1899] 2 Q.B. 191, where it was proved that a person suffering from a dangerous infectious disorder had proper lodging and accommodation, so far as he himself was concerned, at his father's house, but that he could not be properly isolated, and there would be danger of infection to the other inmates of the house if he remained there, it was held that there was evidence that he was "without proper lodging or accommodation" within the meaning of Section 124 of the Public Health Act, 1875. Mr. Justice Day remarking that the section referred to is clearly directed not only to the protection of the sick person himself but to the protection of other persons from infection.

(under Section 123 of the Public Health Act, 1875) provide suitable means of conveyance to and from hospital of persons suffering or recovering from small-pox.

5. The Sanitary Authority should also bear in mind their powers as to dealing with infectious diseases in any tent, van, shed, or similar structure, under Section 9 of the Housing of the Working Classes Act, 1885.

6. Public notice should be given of the penalties to which persons are liable on account of the exposure of small-pox patients, the use without proper precautions of public carriages for the conveyance of persons suffering from small-pox, or of the bodies of those who have died therefrom, the letting of infected houses or rooms, the sale or sending about of infected things, or the throwing into ashpits of infectious rubbish; and proceedings should be taken by the Sanitary Authority in every case in which these provisions are disobeyed. (*See* Public Health Act, 1875, Section 126–129, and Sections 7, 11, and 13, Infectious Disease (Prevention) Act, 1890.)

W H. POWER,
Medical Officer.

Local Government Board,
March, 1901.

(No. 3.)

LONDON.

MEMORANDUM ON THE STEPS SPECIALLY REQUISITE TO BE TAKEN IN PLACES WHERE SMALL-POX IS PREVALENT.

I.—BY BOARDS OF GUARDIANS.

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Under section 7 of the Vaccination Act, 1898 (61 *and* 62 *Vict. c.* 49), *the Local Government Board may by Order, if in their opinion it is expedient by reason of serious risk of outbreak of small-pox, or of other exceptional circumstances, require any Board of Guardians to provide vaccination stations for the vaccination of children with glycerinated calf lymph, or such other lymph as may be issued by the Board, and modify as respects the area to which the Order applies, and during the period for which it is in force, the provisions of that Act requiring the public vaccinator to visit the home of the child, otherwise than on request of the parent; and it will be for Boards of Guardians to make application to the Local Government Board for the issue of such an Order whenever local circumstances appear to them to demand the exercise of the power conferred on the Board by the section in question. It is also provided under section* 13 *of the Vaccination Act,* 1871 (34 *and* 35 *Vict. c.* 98), *that District Medical Officers in attendance upon any person suffering from small-pox shall be entitled to payment from the Guardians for vaccinating or (as the case may be) re-vaccinating any person who is resident in the same house as the sick person, and who could lawfully be vaccinated or (as the case may be) re-vaccinated by a Public Vaccinator at the public expense.*

These provisions, promptly applied in the event of serious risk of an outbreak of small-pox, will in general be found adequate to stop the spread of the disease; but if from neglect of them, or from any other circumstance, cases of small-pox spread in the district, special measures should be taken to expedite, as far as practicable, the vaccination of all unvaccinated persons in the district and to promote the re-vaccination of adults and adolescents who have not already been successfully re-vaccinated.

In order that speedy discovery may be made of all unvaccinated persons, whether born in the district or newly arrived there, it will frequently be desirable that some temporary assistance be given to Vaccination Officers, in the manner provided in Article 10 (2) *of the Vaccination Order*, 1898.

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1. On the occurrence of any prevalence of small-pox the Vaccination Officer should give his first and special attention to the particular localities in which the infection exists.

2. In order that for this purpose he may have the earliest possible information of the occurrence of cases of the disease, the Guardians should invite the Medical Officer of Health to give information to the Vaccination Officer of each case of small-pox as soon as it is notified, and, with the same object, the co-operation of persons who visit among the poor should be secured. They should also instruct their District Medical Officers to give the Vaccination Officer immediate notice of every fresh case of small-pox which comes under their care, and should arrange with the Registrars of Deaths to forward to him immediate notice of each death registered from small-pox. For convenience of transmitting such notices, each District Medical Officer and Registrar should be supplied with forms duly stamped for post, or with post-cards adapted for the purpose. Private medical practitioners may be invited to give similar information.

3. In each locality in which the infection exists, the Vaccination Officer should, with the utmost possible dispatch, personally ascertain what children are unprotected by vaccination, and should use his utmost exertions to obtain the prompt vaccination of all such children. Generally speaking, his own judgment and local knowledge will guide him as to the manner in which his inquiries can best be made; but in infected courts or alleys, as well as in certain kinds of streets, inquiries from house to house, and, in tenement houses, from room to room, will be indispensable.

4. Where any child (between the ages of six months and 14 years) who has not already had small-pox, or has not been duly certified as insusceptible of vaccination, or has not come within the terms of exemption under section 2 of the Vaccination Act, 1898, or whose vaccination is not at the time standing postponed under medical certificate, is found to be unvaccinated, the Vaccination Officer should take steps to procure the vaccination of the child with all practicable speed.

With regard to unvaccinated children, not yet six months old, who may be in infected localities, the Vaccination Officer should advise the parents not to incur the unnecessary risk of waiting for the child to reach that age before having its vaccination performed In no house in which there is small-pox ought any child to remain unvaccinated, unless on medical examination it is pronounced unfit to be vaccinated.

5. All representations made as above should be accompanied with information as to the existing arrangements for vaccination, including any special temporary provisions which may have been made under section 7 of the Vaccination Act, 1898, for Public Vaccination in the district.

6. The Vaccination Officer should make it well known that the Public Vaccinator is at liberty to re-vaccinate all persons who shall not be less than ten years old and shall not have been previously re-vaccinated within a period of ten years, who apply to him for that purpose; and that persons not vaccinated since childhood, who are likely to be exposed to contagion, ought to be re-vaccinated without delay. Above all, this is necessary for persons whose original marks of vaccination are imperfect.

7. In the event of many artizans requiring re-vaccination, and being unwilling to lose part of their working day for the purpose of securing the desired protection, it may be expedient that the Vaccination Officer should confer with the Guardians as to attendances being given by the Public Vaccinator at some specified hour in the evening.

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8. Generally, the Vaccination Officer should take every means to ensure that the vaccination of his whole district is as complete as possible. He should make frequent examination of his birth-lists, and deal, as soon as practicable, with every case of default as it arises; and he should be prompt and diligent in his inquiries respecting the other children to whom his duties extend under section 7 of his "Instructions," as issued by the Local Government Board.

9. The Vaccination Officer should give immediate information to the local Sanitary Authority of any house in which small-pox has appeared, and of which no information has reached him from the Medical Officer of Health, in order that needful means of isolation and disinfection may be taken.

II.—By Sanitary Authorities (London).

The Sanitary Authority of any district into which a case of small-pox may be brought, or in which it may occur, should immediately, on obtaining information of the occurrence, instruct their Medical Officer of Health to give notice to the Vaccination Officer of the Board of Guardians (the Local Authority for vaccination purposes), in order that all practicable measures in regard to vaccination may be taken. The Sanitary Authority should also instruct their officers to assist in the administration of the Vaccination Acts by spreading a knowledge of the advantages of vaccination and re-vaccination, and by giving to the Vaccination Officer any information they may obtain as to children and others unprotected by vaccination.

*The Sanitary Authority themselves should, on any appearance of small-pox within their district, at once proceed (under the powers of the Public Health (London) Act, 1891) to see that proper means to prevent the spread of the disease by ISOLATION OF THE SICK AND BY DISINFECTION OF INFECTED HOUSES AND THINGS, are adopted. Any extension of the disease from the house first infected, or any fresh importation of it, needs to be dealt with in the same way. And as, from the extreme infectiousness of small-pox, every new case is a fresh source of danger, it is of the first importance towards preventing the spread of the disease that the necessary measures of the kind above mentioned should be taken in each case at the earliest possible moment. Hence it is important for every Sanitary Authority to see that their Medical Officer of Health is kept informed, as completely and promptly as possible, of all cases of small-pox occurring in the district. The knowledge obtained through notifications received under section 55, Public Health (London) Act, 1891, should be supplemented by information procured by house to house inquiry in each locality invaded as to cases of modified small-pox that may have escaped recognition or treatment, and by immediate notice from the District Registrars of all deaths from small-pox.**

The hospital treatment of small-pox cases in London under ordinary circumstances devolves upon the Metropolitan Asylums Managers, who, under section 80, Public Health (London) Act, 1891, subject to such regulations and restrictions as the Local Government Board prescribe, may admit any person who is reasonably believed to be suffering from small-pox into a hospital provided by the Managers. The expenses incurred by them for the maintenance of any such person are to be paid by the Board of Guardians of the Poor Law Union from which he is received, but are repayable to the Board of Guardians out of the Metropolitan Common Poor Fund. The admission of a person suffering from an infectious disease into any hospital provided by the Metropolitan Asylums Managers, or his maintenance there, is not to be considered parochial relief, alms, or charitable allowance, and does not entail loss of any right or privilege, or involve any disability or disqualification.

The Metropolitan Asylums Managers are also empowered by section 79 of the Act to provide ambulances for the removal of patients.

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* It must always be remembered that small-pox is liable to be spread by infection, not only from well-marked and easily recognised cases, but also, as indeed frequently happens, from cases of which the nature is not at first evident, especially to medical men unfamiliar with the disease. Such attacks may be, on the one hand, mild and modified cases, which may be mistaken for chicken-pox or other comparatively slight disorder; or, on the other hand, they may be hæmorrhagic or other malignant and rapidly fatal forms in which death may occur before the characteristic rash has had time to develop itself.

The following are the measures which Sanitary Authorities should take:—

1. It is of great importance that all persons suffering from small-pox, and so lodged that the isolation of them from healthy persons cannot be secured without their removal, should as speedily as possible be removed to some special hospital or place for the reception of the sick. Section 66 of the Public Health (London) Act, 1891, gives power to a Justice to order such removal* ; and resort should be had to this provision whenever such a measure seems necessary to prevent the spread of the disease. Similar powers for the necessary detention in hospital of persons suffering from infectious disease are obtainable under section 67 of the same Act. Section 2 of the Public Health (London) Act, 1891, including within the term "nuisance" such overcrowding of a house or any part of a house as is injurious or dangerous to the health of the inmates, whether or not members of the same family, should also receive the special attention of the Sanitary Authority with a view to the abatement of the nuisance under sections 4 and 5 wherever any infectious disease is or threatens to become prevalent in the district. The powers given in sections 72, 73, 74, and 89 of the same Act of 1891 should, if necessary, be exercised with regard to the bodies of persons who die of small-pox.

2. After the removal or death of a patient suffering from small-pox, it is desirable that the remaining inmates of the house, and other persons who are known to have come into contact with infection, should be kept under observation during a period of not less than 14 days, in order that, in the event of any of them contracting the disease, it may be recognized at an early stage, and thus prompt measures may be taken for preventing its further spread.

3. All houses or rooms and things infected with small-pox should be disinfected under skilled direction, and with as little delay as possible after the removal, convalescence, or death of the patient, and for this provision is made in sections 59–65 of the Public Health (London) Act, 1891. To secure the disinfection of houses or rooms being properly performed it will be desirable that it should, in as many cases as possible, be done by the servants of the Sanitary Authority, and to the satisfaction of the Medical Officer of Health. Under section 60 (4) of that Act, temporary shelter or house accommodation is to be provided for the members of any family in which infectious disease has appeared, and who are compelled to leave their dwellings for the purpose of enabling such dwellings to be disinfected by the Sanitary Authority. The Authority are also required by section 59 to provide proper premises, with the requisite apparatus and attendance, for disinfection (preferably by steam) of articles (whether bedding, clothing, or other) which have become infected by any dangerous infectious disease. Often it will be better, instead of disinfecting infected articles (such as bedding and clothing), to destroy them; and the Sanitary Authority have power, under sections 60 and 61 of the Public Health (London) Act, 1891, to do this, and to make compensation for the articles destroyed.

4. As infectious diseases may be spread by the use of public carriages for the conveyance of the sick, the Sanitary Authority should bear in mind the provisions of section 70 of the Public Health (London) Act, 1891, and should provide suitable means of disinfecting public vehicles which may have been unwittingly or negligently used for the conveyance of persons suffering from small-pox.

5. The Sanitary Authority should also bear in mind their powers under section 9 of the Housing of the Working Classes Act, 1885, as to dealing with infectious diseases in any tent, van, shed, or similar structure.

6. Public notice should be given of the penalties to which persons are liable on account of the exposure of small-pox patients, the use without proper precautions of public carriages for the conveyance of persons suffering from small-pox or of the bodies of those who have died therefrom, the letting of infected

* In the case of *Warwick* v. *Graham*, L.R. [1899] 2 Q.B. 101 : 68 L.J. Q.B. 1001 ; 80 L.T. n.s. 773 ; 63 J.P. 599, where it was proved that a person suffering from a dangerous infectious disorder had proper lodging and accommodation, so far as he himself was concerned, at his father's house, but that he could not be properly isolated, and there would be danger of infection to the other inmates of the house if he remained there, it was held that there was evidence that he was "without proper lodging or accommodation" within the meaning of section 124 of the Public Health Act, 1875 (corresponding to section 66 of the Public Health (London) Act, 1891), Mr. Justice Day remarking that the section referred to is clearly directed not only to the protection of the sick person himself but to the protection of other persons from infection.

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houses or rooms, the sale or sending about of infected things, or the throwing into ashpits of infectious rubbish; and proceedings should be taken by the Sanitary Authority in every case in which the provisions with respect to the above matters are disobeyed. (*See* Public Health (London) Act, 1891, sections 63–65, 68–70, and 74.)

W. H. POWER,
Medical Officer.

Local Government Board,
September, 1901.

(No. 4.)

LOCAL GOVERNMENT BOARD.

MEMORANDUM, PREPARED IN THE MEDICAL DEPARTMENT, ON THE CIRCUMSTANCES UNDER WHICH THE CLOSING OF PUBLIC ELEMENTARY SCHOOLS OR THE EXCLUSION THEREFROM OF PARTICULAR CHILDREN MAY BE REQUIRED IN ORDER TO PREVENT THE SPREAD OF DISEASE.

Objects of memorandum.

1. It is attempted in these notes to bring together the information in the possession of the Local Government Board, derived from the reports of the Board's own Medical Inspectors and of local Medical Officers of Health, respecting school closure and exclusion from school as precautions against infection, with a view to indicate the best means of preventing the spread of disease by school children among their fellows, while avoiding any unnecessary interruption of the work of education.

Regulations of Education Department.

2. In the Code of Regulations approved by the Lords of the Committee of Council on Education, the following Article (Art. 88) prescribes, as one of the general conditions required to be fulfilled by a Public Elementary School in order to obtain an annual Parliamentary grant, that—

"The managers must at once comply with any notice of the sanitary authority of the district in which the school is situated, or any two members thereof acting on the advice of the Medical Officer of Health, requiring them for a specified time, with a view to preventing the spread of disease, or any danger to health likely to arise from the condition of the school, either to close the school, or to exclude any scholars from attendance, but after complying they may appeal to the Department if they consider the notice to be unreasonable."

Article 83 (a) prescribes that "if a school has been closed during the " year under medical authority, or for any unavoidable cause, a corre- " sponding reduction is made from the number of meetings" (400 a year) " required.

Article 101* provides that where the Education Department "are " satisfied that by reason of a notice of the Sanitary Authority under Art. 88, " or any provision of an Act of Parliament, requiring the exclusion of " certain children, or by reason of the exclusion under medical advice of " children from infected houses, the average attendance has been seriously " diminished, and that consequently a loss of annual grant would, but for " this Article, be incurred, the Department have power to make a special " grant not exceeding the amount of such loss in addition to the ordinary " grant."

Diseases principally requiring action.

3. The diseases for the prevention of which school closure, or the exclusion of particular children, will be required are principally those which spread by infection directly from person to person, such as diphtheria, scarlet fever, measles, whooping-cough, epidemic influenza, small-pox, and rötheln. More rarely, the same questions arise in connection with enteric fever and diarrhœal diseases, which spread not so much by direct infection from person to person as indirectly through the agency of local conditions, such as infected school privies.

4. It will be seen that Article 88 quoted above confers upon sanitary authorities an alternative power with respect to public elementary schools.

(A.) To cause particular scholars to be for a specified time excluded from attendance, or

(B.) To require the school to be closed for a specified time.

Exclusion of scholars:

5.—*A. First, as to exclusion from school of particular scholars.*—Here it will be convenient to consider the circumstances under which the requirements of the public health will be satisfied by the less severe measure of the exclusion from school of particular children.

(*a.*) It may be laid down as a universal principle that all children suffering from any dangerous infectious disorder (*i.e.*, of a nature dangerous to some of the persons attacked by it, however mild in other cases) should be excluded from school until there is reason to believe that they have ceased to be in an infectious condition (*see* section 126 of the Public Health Act, 1875).

from infected houses,

(*b.*) Furthermore, as it is rarely possible to provide effectual separation of the sick from the healthy within the homes of children of the class attending public elementary schools, it must commonly be necessary that all children of an infected household should be excluded from school; first because otherwise such children might attend school while suffering from the disease in a latent form, or at an unrecognized stage, and, secondly, because it is known that infection may attach itself to, and be conveyed by, the clothes of a person living in an infected atmosphere, even though the person himself remain unaffected. The same considerations will sometimes make it desirable to prohibit the attendance at school of all children from a particular street or hamlet.

from particular localities.

In the case of infectious diseases involving little or no danger to life, such as mumps or skin diseases, school interests may be more particularly considered. In such case, however, it will usually be well for the Medical Officer of Health to advise the managers to prohibit the attendance of every child while in an infectious state.

Closing of schools:

6.—*B. Secondly, as to the closing of schools.*—This, by more serious interfering with the educational work of a district, is a much more grave step for a sanitary authority to take than to direct the exclusion of particular scholars. It is a measure that seldom ought to be enforced, except under circumstances involving imminent risk of an epidemic, nor even then as a matter of routine nor unless there be a clear prospect of preventing the propagation of disease such as could not be looked for from less comprehensive action.

when to be required.

The mere fact that in an epidemic many of the sufferers are school children does not necessarily show that the disease was caught at school; but the school may with probability be regarded as spreading infection if in a large majority of households attacked the first case be a child attending school; and with still greater probability if a number of children living at a distance from one another, and with no circumstances in common, except that they attend the same school, should be simultaneously attacked, and if it can be ascertained that a child or teacher in an infectious state has actually been attending the school.

Duty of Medical Officer of Health when infectious disease occurs.

7. By Article 18 (6) of the Board's Order of 23rd March, 1891, the Medical Officer of Health on the occasion of an outbreak of dangerous infectious disease is to advise the persons competent to act as to the measures to be taken to prevent the extension of the disease. If, therefore, he finds that the children of infected households are attending school, he should send notice of the fact to the schoolmaster, and give such advice as appears to him to be necessary with regard to the exclusion of the children from school, and as to the time for which such exclusion should continue.

Where the number of children to be excluded is small, and the schoolmaster acts on the advice of the Medical Officer of Health, it may not be necessary to take formal action under Article 88 of the code; but where the number of children whom it is desirable to exclude from school is such as is likely seriously to diminish the average attendance, or where the advice of the Medical Officer of Health is not followed, and there is danger of the disease spreading by means of the school, notice for the exclusion of the children in question should be made in accordance with the requirements of Article 88.

Aid which schoolmasters and others can give.

The attention of school attendance officers and of schoolmasters should also be drawn to the following considerations. Frequently they themselves will obtain the earliest information of the occurrence of infectious disease among scholars, and it is most desirable that such officer or master should without delay communicate the facts to the Medical Officer of Health. Absence of any child from school on the plea that it is suffering under one of the before-mentioned diseases, and absence of several children of one family from school at the same time, no matter what name be given to the complaint that keeps them at home, should be reported to the health officer. In practice it has been found that this notification of absentees has materially aided the local health officer in taking measures for the suppression of infectious disease, to the advantage alike of the district and of the school. Furthermore, schoolmasters may properly be asked to take note, especially when an epidemic threatens or is present, of symptoms occurring in any of their scholars that may indicate the commencement of disease, febrile in nature. Besides heat of skin, such symptoms are shivering, headache, and langour, especially if commencing suddenly, vomiting, rashes on the skin, and sore throat. When scarlet fever or diphtheria is about, every trace of sore throat should be looked upon as suspicious. In any case where such symptoms are observed, the safest course will be to exclude the child from school until assurance can be had that it may attend school without harm to itself or danger to other scholars.

Exclusion of particular scholars; duration of.

8. As regards duration of exclusion from school of particular children, the time to be specified will vary in different diseases and different cases, and in this matter the sanitary authority will doubtless be guided by the advice of their Medical Officer of Health.

Considerations which should determine period.

Medical officers of health, having to specify a time during which any scholars are to be excluded from attendance at any school, should have regard as far as practicable to the circumstances of the particular scholars suffering from infectious disease or living in infected households. Not only the nature of the infection and the length of illness, but the environments of the individual as affecting the retention of infection will deserve consideration. The period of exclusion, for example, will need to be different according to the conditions of a patient's lodgment, according to the sufficiency of the separation that can be effected between a patient and excluded scholars, and according to the opportunities of effectual disinfection that can be afforded to the household. Thus a hard and fast rule, such as has been laid down in some districts where scarlatina has been present, that no child shall go to school from an infected house for three months after the disease has begun in that house, is not to be commended. It is indeed possible that under the circumstances of a particular household, a child convalescent from scarlatina or living in the same house with convalescents should not in the interests of other children be permitted to return to school until after so long a period as this; but the same ought not to be assumed of all households in the district that may be invaded by scarlatina. The better plan would be for the sanitary authority to secure, during a shorter period, the exclusion of individual sick persons and their housemates from school; and when that period is about to expire to cause fresh inquiry to be made as to the expediency of further exclusion, and, if found requisite in particular cases, to cause fresh notice to be given to the school managers.

Period of exclusion may be prolonged by new notice.

Whether exclusion or school closure to be preferred.

9. In deciding whether an outbreak of infectious disease among children of school age may be best combated by closing the school, or whether it will suffice to exclude the children of infected households, the two most important points to be considered are:—

(*a.*) The completeness and promptness of the information received by the officers of the sanitary authority respecting the occurrence of infectious cases.

(*b.*) The opportunities which exist for intercourse between the children of different households elsewhere than at school.

When exclusion system to be preferred.

10. (*a.*) The more prompt and full the knowledge of cases of infectious disease that the sanitary authority are able to obtain, the better will be the prospect of checking such disease by keeping away from school the children of infected households, and the less will be the necessity for closing schools.* If the cases

* Information obtainable under the Infectious Disease (Notification) Act, 1889, will be specially useful in this direction.

be few in number, and their origin known, the exclusion from school of the children of infected households will probably suffice, but this measure will fail where there are many undiscovered or unrecognized cases, or where the known centres of infection are very numerous.

When total closure of school preferable.

Commonly, the failure of carefully considered measures of exclusion to stay the spread of an epidemic which shows a special incidence upon school children, may be regarded as pointing to the continued attendance at school of children with the prevalent disease in a mild or unrecognized form, and a strong case will appear for the closing of schools.

If by reason of the absence or exclusion of a large number of children, the attendance at a school be greatly reduced, it may be found better to close it altogether. This is especially apt to occur in the case of epidemics of measles, a disease which is very infectious in the early stages, before the characteristic rash has appeared, and while the symptoms resemble those of a common cold.

Closure of schools:

in rural districts,

in populous localities,

11. (*b.*) The second material consideration, in deciding as to the desirability of closing schools during the prevalence of infectious disease, is the amount of opportunity for intercommunication between the members of different households elsewhere than at school. In sparsely populated rural districts, where the children of different households, or of separate hamlets rarely meet except at, or on their way to, the village school, the closing of the school is likely to be effectual in checking the spread of disease. It is less likely to be useful in a town or compact village (particularly where houses are sub-let and yards are in common), where the children of different households when not at school spend their time in playing together, and often run in and out of each other's houses. But it must be remembered that children when at play out of doors are brought into much less close association with each other than when in school.

In rural districts, where epidemic diseases are less frequently prevalent, school closing may be required as an exceptional measure to meet an exceptional state of things. As regards more populous places, it must not be forgotten, that if schools were to be closed whenever an infectious disease was prevalent, there are many places where schools would hardly ever be open.

for purposes of disinfection, &c.,

It will sometimes be necessary to close a school for a day or two to allow of the rectification of sanitary defects of a nature to extend disease, or in order that the school may be disinfected or purified. It has happened that infectious sickness in the master's family has forbidden the attendance of scholars. These more temporary and occasional closures of schools are contemplated in the Education Code, and are to be regarded as having a real importance of their own.

where many schools exist.

12. In places where there are several public elementary schools, if an outbreak of infectious disease be confined to the scholars of one particular school, it may be sufficient to close that school only. But where different schools have all appeared to aid in the spread of disease (though perhaps to an unequal extent) the sanitary authority may consider it advisable that all should be closed lest children in an infectious state who previously attended the schools that are closed, should be sent to others that might remain open.

Sunday and private schools.

It must be remembered that sanitary authorities have no power in respect of Sunday Schools, or other private schools: except in so far as these many contravene sect. 91 (5), sect. 126, or other provisions of the Public Health Act, 1875; but it will often be expedient to invite the co-operation of managers of such schools in efforts for securing the public health. Experience shows that they are usually ready to defer to the representations of the authority responsible for the public health of the district.

Duty of Medical Officer of Health as to reporting.

Grounds for action to be stated.

13. The Medical Officer of Health has not power to order the closing of a school; his function in this respect is advisory only. Reports of Medical Officers of Health to sanitary authorities, advising the closure of a school or schools in any district, are to be treated as "special" reports within the meaning of the General Order of the Local Government Board of March 23rd, 1891, and copies of them are required by Art. 18 (15) and (16) of that Order to be sent to the Board and to the County Council. These reports should state the grounds upon which the Medical Officer of Health advocates the closure of the school or schools in preference to the exclusion of particular scholars.

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Notices requiring closure of schools.

Notices to specify definite periods.

14. All notices of the sanitary authority for the closing of Public Elementary Schools should be addressed in writing to the Managers, and should state the grounds on which the closing is deemed necessary.

All such notices shall specify a definite time during which the school is to remain closed; this should be as short a period as can be regarded as sufficing on sanitary grounds, since a second notice may be given before the expiration of the first, if it should be found necessary to postpone the re-opening of a school. The Managers of Schools, after complying with the requirements of the sanitary authority, have the right of appeal to the Education Department, if they consider any notice to be unreasonable.

W. H. POWER.

September, 1901.

B.

(No. 1.)

SHIP-BORNE RATS AND PLAGUE.

Local Government Board,
Whitehall, S.W.,
29th April, 1901.

SIR,

I am directed by the Local Government Board to advert to their circular letter of 9th October, 1900, enclosing copies of Memoranda prepared by their Medical Officer for the assistance of Sanitary Authorities and their officers in view of the possibility of the occurrence of cases of plague in this country. In the "Plague Memorandum" attention was specially drawn to the facts that plague affects rats as well as the human subject, and that the rat and man are as regards plague reciprocally infective.

I am now to forward to the Sanitary Authority the enclosed copies of a further Memorandum which has been prepared by the Board's Medical Officer with regard to the risk of importing plague into this country by means of plague-infected rats on board ships, and the steps which should be taken by Sanitary Authorities of seaports with the view of preventing the introduction of the disease in this way; and I am to request that the Sanitary Authority will instruct their officers to use their best efforts to secure the carrying into effect of the suggestions which this Memorandum contains.

A copy of the Memorandum should be given to the Medical Officer of Health and another to the Inspector of Nuisances.

I am, Sir,
Your obedient Servant,
S. B. PROVIS,
Secretary.

The Clerk to the Sanitary Authority.

(No. 2.)

Circular.

Councils of Metropolitan and other Boroughs, and of Urban and Rural Districts.

TUBERCULOSIS.

Local Government Board,
Whitehall, S.W.,
6th September, 1901.

SIR,

I am directed by the Local Government Board to state that at the recent Congress on Tuberculosis Professor Koch called in question the correctness of the opinion that tuberculosis can be transmitted from animals to man. The

views expressed by Professor Koch on this subject have not received the general assent of scientific men; but, having regard to the great importance of the matter, His Majesty's Government have thought it right to accede to a request made by the Congress that there should be an inquiry with respect to it. A Royal Commission has accordingly been appointed to inquire and report whether tuberculosis in animals and man is one and the same disease; whether animals and man can be reciprocally infected with it; under what conditions, if at all, the transmission of the disease from animals to man takes place; and what are the circumstances favourable or unfavourable to such transmission.

The Board are desirous, however, of impressing upon the local authorities concerned that pending the investigations and report of the Royal Commission there should be no relaxation on their part or on that of their officers in the taking of proper measures for dealing with milk from tuberculous cows and with tuberculous meat which may be intended for the food of man. It is, in the opinion of the Board, of much importance that these measures should continue to be taken, and they rely on this being done.

At the same time the Board may observe that representations have been made to them to the effect that the action of the officers of local authorities in the seizing of tuberculous meat is not uniform. The Royal Commission on Tuberculosis, in the report which they made in 1898, referred to the degree of tubercular disease which should cause a carcase, or part thereof, to be seized. They stated as follows:—

"We are of opinion that the following principles should be observed in the inspection of tuberculous carcases of cattle:—

(*a.*) When there is miliary tuberculosis of both lungs (*b.*) When tuberculous lesions are present on the pleura and peritoneum ... ... (*c.*) When tuberculous lesions are present in the muscular system, or in the lymphatic glands embedded in or between the muscles ... ... (*d.*) When tuberculous lesions exist in any part of an emaciated carcase	The entire carcase and all the organs may be seized.
(*a.*) When the lesions are confined to the lungs and the thoracic lymphatic glands ... ... (*b.*) When the lesions are confined to the liver ... (*c.*) When the lesions are confined to the pharyngeal lymphatic glands ... ... (*d.*) When the lesions are confined to any combination of the foregoing, but are collectively small in extent	The carcase, if otherwise healthy, shall not be condemned, but every part of it containing tuberculous lesions shall be seized.

"In view of the greater tendency to generalisation of tuberculosis in the pig, we consider that the presence of tubercular deposit in any degree should involve seizure of the whole carcase and of the organs.

"In respect of foreign dead meat, seizure shall ensue in every case where the pleura have been 'stripped.'"

The Board draw attention to this matter in the circular letters which they addressed to the Councils of Boroughs and Urban and Rural Districts on the 11th March, 1899, and they desire again to refer to it and strongly to urge upon the Council to direct those of their officers who are employed as Meat Inspectors to act in accordance with the principles laid down by the Royal Commission.

It is also of much importance that a person who is to act as a Meat Inspector should possess proper qualifications for the office. He should, as was pointed out by the Royal Commission, be acquainted with—

(*a.*) The law of meat inspection.

(*b.*) The names and situations of the organs of the body.

(*c.*) Signs of health and disease in animals destined for food, both when alive and after slaughter.

(*d.*) The appearance and character of fresh meat, organs, fat and blood, and the conditions rendering them, or preparations from them, fit or unfit for human food.

The Board trust that in making appointment of officers on whom will devolve the duty of acting as Meat Inspectors, the Council will satisfy themselves that the person appointed possesses adequate knowledge on these subjects.

The Board may at the same time draw attention to Article 19 (7) of their General Order of the 23rd March, 1891, with respect to the duties of an Inspector of Nuisances in relation to the inspection and seizure of meat. There is a similar provision in Article 19 (6) of the Order in force in London, viz., the Sanitary Officers (London) Order, 1891.

Any Inspector of Nuisances or Sanitary Inspector to whom either of these Orders applies is required in any case of doubt in connection with the inspection and seizure of meat to report the matter to the Medical Officer of Health, with the view of obtaining his advice thereon. The Board think it desirable that any such Inspector of Nuisances or Sanitary Inspector should be reminded of his duty in this respect.

I am, Sir,

Your obedient Servant,

S. B. PROVIS,

Secretary.

The Town Clerk, or
The Clerk to the Urban or
Rural District Council.

(No. 3.)

Circular.

County Councils.

THE ISOLATION HOSPITALS ACT, 1901.

Local Government Board.
Whitehall, S.W.,
6th September, 1901.

SIR,

I am directed by the Local Government Board to draw attention to the Isolation Hospitals Act, 1901 (1 Edw. 7, c. 8), which has recently received the Royal Assent and which has for its object the amendment in various particulars of the Isolation Hospitals Act, 1893 (56 & 57 Vict c. 68).

Transfer by Local Authority of Hospitals for use as Isolation Hospitals.

Urban and rural district councils are enabled by the Public Health Act, 1875 (38 & 39 Vict. c. 55), to provide hospitals for their districts. Moreover, under the provisions of the same statute, districts can be combined for hospital purposes by means of Provisional Orders made by the Local Government Board and confirmed by Parliament, and, where this course is adopted, the hospital is provided by a joint board constituted in accordance with the Act.

Hitherto there has been some doubt as to the extent of the power of a district council or joint board, who had provided a hospital under the Public Health Act, 1875, to transfer their hospital to the county council. Section 1 (1) of the new Act provides that any local authority (including a joint board) within the meaning of the Public Health Act, 1875, who have provided under that Act, or any local Act, a hospital for the reception of the sick, may, with the sanction of the Local Government Board, and with the consent of the council, transfer it to the council of the county within which the hospital, or any part of the district of the authority, is situate.

The Board may give their sanction to the transfer subject to such terms and conditions as they think fit, but their sanction is not to be given unless they are satisfied that hospital accommodation sufficient for the needs of the district has been or will be provided. (Section 1 (2).)

Any money paid to a local authority on a transfer of a hospital thus effected is to be applied as the Board direct, either in repayment of any loan of the local authority, or for any other purpose for which capital moneys may properly be applied. (Section 1 (3).)

Any hospital transferred in accordance with these provisions must be appropriated to a district formed under the Isolation Hospitals Act, 1893, and may be adapted as an isolation hospital, and any hospital so appropriated is to be treated as if it had been originally established under that Act for the district. (Section 1 (4).)

It is further provided that the expenses incurred by a county council in or incidental to the transfer of any hospital under the new Act are to be defrayed as structural expenses incurred by a hospital committee within the meaning of section 17 of the Isolation Hospitals Act, 1893. (Section 1 (5).)

Contributions by County Councils to Hospitals provided by Local Authorities.

Section 21 of the Isolation Hospitals Act, 1893, empowers a county council to contribute out of the county rate capital or annual sums towards the structural or establishment expenses of isolation hospitals established under that Act, where they deem it expedient for the benefit of the county so to do; but hitherto no such contribution could be made in respect of a hospital provided under the Public Health Act, 1875.

The new Act, however, now declares that the power conferred on a county council by section 21 of the Act of 1893 includes the power to contribute, in manner provided by that section, to any hospital provided by a local authority (including a joint board) within the meaning of the Public Health Act, 1875, for the reception of patients suffering from infectious disease, whether within the area of the county council or not. But the consent of the Board is required to an annual contribution under this provision by the county council to a hospital, the cost of providing which, or of any permanent extension or enlargement of which, has been defrayed otherwise than out of borrowed money. (Section 2 (1).)

Section 22 of the Act of 1893 enables a county council to borrow money for the purpose of that Act, but requires that the money shall be repaid to the county council out of the local rate of the district concerned. This requirement has presented a difficulty in the way of money being borrowed for the purpose of a contribution by a county council towards the expense of an isolation hospital, as the locality intended to be benefited would have to repay the loan.

For the future, a county council will, by virtue of subsection (2) of section 2 of the new measure, be specifically enabled to borrow in manner provided by section 22 of the Act of 1893 any sum required for the contribution of a capital sum under section 21 of that Act, as amended by the new Act, and sums so borrowed will not be repayable to the county council out of the local rate.

Power of Hospital Committees under the Isolation Hospitals Act, 1893, *to contract for Hospital Accommodation.*

Difficulties have been experienced by hospital committees under the Act of 1893 in hiring temporarily a hospital from a district council whilst the committee were themselves erecting a permanent hospital, and also owing to the want of power on the part of a hospital committee to send patients from their district to the hospitals of other authorities, and pay for them when the circumstances render this desirable, for example, in the case of an epidemic where the committee's hospital is full.

These difficulties are met by section 3 (1) of the new Act, which empowers the hospital committee of any hospital district under the Isolation Hospitals Act, 1893, to make and give effect to agreements for the use of any hospital or part of a hospital, or for the reception into any hospital of the sick of their district, upon payment of such annual or other sums as may be agreed upon.

Subsection (2) of the same section provides that any expenses incurred by a hospital committee in this manner are to be defrayed under the Act of 1893 as structural, establishment, or patients' expenses, in such proportions as the committee direct.

Rate of Interest on Monies repayable to County Councils.

Hitherto monies borrowed by a county council, or expended by them for the purposes of the Act of 1893, have had to be repaid to them out of the local rate, with interest at a fixed rate of 4 per cent. per annum.

The provision in regard to the rate of interest is now repealed, and in lieu it is provided that the rate of interest shall be such as may be agreed upon between the county council and the hospital committee concerned, or, in default of agreement, may be determined by the Board. (Section 4.)

Appeals to Board as to formation of Hospital Districts.

The Act of 1893 empowers a county council to make an order constituting a hospital district, but under section 8 (3) of the Act any local authority in the proposed district, who objects to the formation of such a district, or to the addition to, or abstraction from, such a district of any local area over which they have jurisdiction, may appeal to the Board, and the decision of the Board is final.

Some doubt has been felt whether, upon an appeal under these provisions, the Board could confirm or disallow the order of the county council, or whether they could modify it.

This doubt is set at rest by section 5 of the new Act, which provides that on any appeal against any order including any area in a hospital district under subsection (3) of section 8 of the Isolation Hospitals Act, 1893, the Board may by their decision confirm, disallow, or modify the order as they think fit.

Local Authorities in Rural Districts.

Where a rural district is included in a hospital district under the Act of 1893, the rural district council are the local authority for the purposes of the Act, but where a parish in a rural district is so included, the parish council or parish meeting have hitherto been the local authority. Section 26 of that Act provides that the local rate out of which the expenses are to be paid shall be the rate out of which the expenses incurred in the execution of the Acts relating to public health are directed to be paid, and that in the case of a contributory place the expenses shall be deemed to be special expenses. Parish councils and parish meetings, however, do not raise the rate out of which special expenses under the Public Health Acts are paid, and questions have arisen as to the payment of the expenses under the Act of 1893 where a contributory place consisting of a parish was concerned.

Section 6 (1) of the new Act now provides that the rural district council shall, to the exclusion of any other authority, be the local authority in the case of any contributory place. At the same time, in order to preserve the right of appeal, which a parish council possess as a local authority, against the formation of a proposed hospital district under section 8 (3) of the Act of 1893, it is provided that the parish council shall have the same right of appeal to the Board under that subsection as a local authority.

It is further provided that any liability which immediately before the passing of the present Act attached to the local authority in respect of a contributory place, being a parish, shall be transferred to and discharged by the rural district council. (Section 6 (2).)

Copies of Orders under section 9 of the Act of 1893 to be sent to Board.

As the council are aware they are required by section 9 of the Act of 1893, upon the conclusion of a local inquiry by them as to the necessity for the

establishment of an isolation hospital, to make an order either dismissing the petition for the establishment of such a hospital, or constituting a hospital district and directing an isolation hospital for such district to be established.

The new Act requires that the council shall, as soon as may be, send to the Board a copy of any order so made by them. (Section 7.)

Representation of County Councils on Hospital Committees.

Section 10 of the Act of 1893 provides for the constitution of hospital committees in hospital districts formed under the Act. These committees may consist wholly of members of the county council, or partly of members of the county council and partly of representatives of the local area or areas in the district, or wholly of such local representatives.

Thus, hitherto, a county council could only be represented upon a hospital committee by members of their own body.

This is altered by section 8 of the new Act, under the operation of which the representatives of the county council upon a hospital committee may be members of the council or not.

I am, Sir,

Your obedient Servant,

S. B. PROVIS,

Secretary.

The Clerk of the
County Council.

(No. 4.)

Circular,

Guardians.

THE VACCINATION ACTS, 1867 TO 1898.

Local Government Board,
Whitehall, S.W.,
17th September, 1901.

SIR,

I am directed by the Local Government Board to state that they have had occasion to consult the Law Officers of the Crown upon certain questions which have recently arisen under the Vaccination Acts, 1867 to 1898, more particularly in connection with proceedings taken with a view to procuring an order for the vaccination of a child under the provisions of section 31 of the Vaccination Act, 1867.

The Board think it desirable that boards of guardians should be informed of the views which, under the advice of the Law Officers, the Board entertain in respect to the points hereafter mentioned.

If in any case where an application is made to justices for an order for the vaccination of a child under section 31 of the Act of 1867, an objection is taken to the proceedings on any ground which may be antagonistic to the views expressed in this letter, and the justices seem inclined to dismiss the summons on that ground, the Board suggest that the justices should be made aware of their opinion on the subject, and of the fact that the opinion is based on the advice of the Law Officers of the Crown.

Service of Public Vaccinator's Notice under section 1 (3) *of the Vaccination Act*, 1898.

It is not necessary that the notice to be given by a public vaccinator of his intention to visit the home of a child in order to offer to vaccinate it should be served personally upon the parent, or other person having the custody of the

child, to whom it is given, or that it should be served by the Public Vaccinator or his deputy in person. It will be sufficient if the notice is served by post by prepaid letter, and the letter need not be registered.

Service of Notice to procure a child's Vaccination under section 31 *of the Vaccination Act*, 1867.

Neither is it necessary that the notice to procure a child's vaccination referred to in section 31 of the Vaccination Act, 1867, which must be given as a preliminary to any proceedings under that enactment, should be served personally upon the parent, or other person having the custody of the child, to whom it is given, or that it should be served by the Vaccination Officer or by his deputy in person. It will be sufficient if this notice also is served by post by prepaid letter, and the letter need not be registered.

Procedure under section 31 *of the Act of* 1867 *for an Order for a child's Vaccination.*

As the foundation for proceedings under section 31 of the Act of 1867, it is necessary that an information in writing should be given to a justice stating (1) that the child with reference to whom the proceedings are taken has not been, or that the Vaccination Officer has reason to believe that it has not been, successfully vaccinated; (2) that the Vaccination Officer has given to the parent, or person having the custody of the child, notice to procure its being vaccinated; and (3) that this notice has been disregarded. Care should of course be taken by the Vaccination Officer to see before laying any information that the child is still alive, that he has not received in respect of the child a valid certificate of insusceptibility, or of conscientious objection on the part of the child's parent, and that he has not received a valid certificate postponing the child's vaccination. Upon this information the justice may issue a summons to the parent or other custodian of the child, but upon the hearing of the summons the question to be determined is whether the child has or has not been vaccinated, or has already had the small-pox.

Irrelevancy of section 1 (3) *of the Vaccination Act*, 1898, *to proceedings under section* 31 *of the Act of* 1867.

The provisions of section 1 (3) of the Vaccination Act, 1898, have no relevancy to proceedings under section 31 of the Act of 1867. Consequently, upon the hearing of the summons under the last-mentioned enactment for an order for the vaccination of a child, it will not be requisite for the prosecutor to prove, as part of his case, either that the Public Vaccinator of the district gave notice of his intention to visit the home of the child in order to vaccinate it, or that he did in fact visit the child's home and offer to vaccinate it.

Irrelevancy of Notice to procure a child's Vaccination upon hearing of a summons for an Order for Vaccination.

Nor is it necessary upon the hearing of such a summons as above referred to that the prosecutor should, in the first instance, prove as part of his case that a notice to procure the child's vaccination as mentioned in section 31 of the Act of 1867 was in fact given, and strictly speaking no point in regard to this notice can properly be raised.

Proof of service and contents of Notice mentioned in section 31 *of the Act of* 1867, *if required by Justices.*

In case, however, the justices before whom the summons is heard hold, in disregard of the opinion expressed in the last preceding paragraph, that it is incumbent upon the prosecutor, either as part of his original case or by way of reply to a defence that may be raised touching this matter, to prove that a notice to procure the child's vaccination was given to the defendant, or to prove the contents of such a notice, the following points should be borne in mind :—

(*a.*) The service of such a notice will be *primâ facie* established by showing that it was sent to the defendant properly addressed, prepaid, and posted.

(*b.*) It is not essential, in order to prove the contents of such a notice, either to give notice to the defendant to produce the actual notice that was given, or to put in evidence an exact or duplicate copy of it.

(*c.*) The contents of such a notice may be sufficiently proved by verbal evidence.

Advisability of keeping accurate counterfoil of Notice under section 31 *of the Act of* 1867.

It will, at the same time, be desirable, in order that there may be no doubt as to the exact terms of the notice in question, that the Vaccination Officer should, when using for the purposes of section 31 of the Act of 1867, one of the printed forms of notice to procure the vaccination of a child with which he has been furnished, either

(1) Fill in upon the counterfoil annexed to the form an accurate copy of the particulars filled in upon the form itself, so that the counterfoil shall, in fact, contain a duplicate of the notice served;

Or (2) make a duplicate with carbon paper on the form now supplied for this purpose by the Local Government Board.

This counterfoil or duplicate should be available at the hearing, and may be referred to by the Vaccination Officer for the purpose of establishing the contents of the notice actually given.

The Board request that a copy of this circular may be given to each Vaccination Officer in the Poor Law Union. Copies are enclosed for this purpose.

I am, Sir,

Your obedient Servant,

S. B. PROVIS,

Secretary.

The Clerk to the Guardians.

(No. 5.)

METROPOLIS. Small-pox.

Vaccination and Re-vaccination.

Boards of Guardians.

Local Government Board,
Whitehall, S.W.,
25th September, 1901.

SIR,

Referring to the increase of small-pox in the Metropolis within the last few weeks, and to the probability that the outbreak which has set in may become serious, the Local Government Board are desirous that the attention of the several Metropolitan Boards of Guardians should be at once specially given to the state of vaccination in their respective unions and parishes, with a view to the prompt vaccination of all children or other persons who may not yet have been vaccinated, and to the promotion of re-vaccination amongst adolescents and adults.

With regard to the vaccination of children, it appears to the Board of pressing importance that the inquiries which the Vaccination Officers are required by their instructions to make on the birth lists in each case of default in vaccination should be duly and punctually made.

The Board regret to state that in many of the metropolitan unions and parishes this has not been the case; and that in the Metropolis generally there are very many children who are unprotected by vaccination.

In this connection I am to draw the attention of the Guardians to Article 28 of the Vaccination Order, 1898, under which they are required from time to time to ascertain whether the Vaccination Officer is performing the duties imposed on him by the Vaccination Acts, 1867 to 1898, of enforcing the provisions of those Acts, and the duties imposed upon him by the Order; to require the due performance by him of such duties; and, in case of any continued neglect on his part, to report the same to the Local Government Board.

The Board trust, therefore, that the Guardians will see that their Vaccination Officers immediately take such steps as may be necessary to deal effectively with the arrears which may have accumulated in the union or parish, and to ensure that in all further cases of default the measures required by the Vaccination Order, 1898, are promptly taken.

In the course of the visits which the Vaccination Officers, in the execution of the duty above referred to, have to make, they should now be more than usually diligent in ascertaining, from all available sources of information, whether there are residing in the several localities any other children than those whose names are in their birth lists who are not vaccinated, and they should lose no time in taking the requisite steps to obtain as far as possible the vaccination of such children.

The small-pox, during the present outbreak, has as yet severely affected only a few localities, but the experience of former outbreaks shows that it may speedily be imported into others, until it becomes generally diffused. The extent of mischief, however, which it may do in any locality into which it is imported will, so far as the Guardians are concerned, mainly depend (1) on the extent to which the inhabitants of the locality are already protected by vaccination, and (as regards adolescents and adults) by re-vaccination; and (2) on the promptitude of the measures taken, immediately upon the importation of the disease, to secure the vaccination or re-vaccination of any who may be unprotected.

The Vaccination Officer, therefore, on learning of such importation, should immediately make inquiries (if need be from house to house) as to vaccination throughout the locality; and he should, besides his express duty of seeing that all children illegally unvaccinated are vaccinated as soon as possible, impress on parents of unvaccinated children the extreme danger, under the circumstances, of delaying the vaccination, and represent, as far as he has opportunity, to adolescents and adults who have not been successfully re-vaccinated within the last ten years, the importance of re-vaccination.

It is desirable that arrangements should be made with the Medical Officers of Health and District Medical Officers, whereby the Vaccination Officer may be informed of any outbreak of small-pox which may occur within their respective districts, and that medical practitioners generally should be invited to give him similar information.

The Board are well aware that in some unions and parishes assistance will be required by the Public Vaccinators and Vaccination Officers to enable these measures to be carried out with the promptitude which is requisite; and the Board will give their immediate attention to any proposal which the Guardians, on reviewing the circumstances of their union or parish, may think it necessary to make in this respect.

Copies of a memorandum on the steps which should be taken in localities where small-pox is prevalent are enclosed. A copy should be given to each Vaccination Officer.

I am, Sir,

Your obedient Servant,

S. B. PROVIS,

Secretary.

To the Clerk to the Guardians.

(No. 6.)

APP. A, No. 17.

Memoranda and Circulars issued in 1901.

METROPOLIS. Small-pox.

Metropolitan Borough Councils.

Local Government Board,
Whitehall, S.W.,
25th September, 1901.

SIR,

I am directed by the Local Government Board to bring under the attention of the Metropolitan Borough Councils the fact that Small-pox has recently undergone some considerable increase in London, and that its extension has involved a number of Metropolitan Sanitary Districts.

The circumstances is the more noteworthy, since at this season of the year Smallpox in London is, as a rule, at its lowest ebb.

The Board attach very great importance to the most energetic measures being taken in connection with the cases which are occurring, with the view of preventing the spread of infection, and they will be obliged to the Council if they will specially instruct their Medical Officer of Health in every case which may be notified to him or which may come to his knowledge, immediately to visit the house where the disease has broken out, and at the earliest possible moment to take such measures as may be necessary to secure as far as practicable the isolation of the patient, the vaccination of any persons who may have been exposed to infection, and the disinfection of the premises, and any further action which the circumstnnces will admit of for the purpose of checking the extension of the disease.

The Board deem it desirable that the Authority should, as regards each case, be informed precisely of the measures which have been taken by the Medical Officer of Health, and they will be glad to be furnished with copies of the reports which are made by him on the subject.

Copies of a Memorandum on the steps specially requisite to be taken in places where Small-pox is prevalent are enclosed. A copy should be given to every Medical Officer of Health and Sanitary Inspector in the Metropolitan Borough.

I am, Sir,
Your obedient Servant,
S. B. PROVIS,
Secretary.

The Clerk to the
Metropolitan Borough Council.

(No. 7.)

Circular.

Guardians in Home Counties.

SMALL-POX MEMORANDUM.

Local Government Board,
Whitehall, S.W.,
6th December, 1901.

SIR,

I am directed by the Local Government Board to refer to the present outbreak of small-pox in London, and to state that, in view of the fact that some cases have also occurred in the neighbourhood of the metropolis, they think it right to draw the attention of the Guardians to a memorandum prepared by the

Board's Medical Officer with regard to the steps specially requisite to be taken in places where small-pox is prevalent, of which copies are enclosed. A copy should be given to each Public Vaccinator and Vaccination Officer in the Poor Law Union.

I am, Sir,
Your obedient Servant,
S. B. PROVIS,
Secretary.

The Clerk to the Guardians.

(No. 8.)

Circular.

Councils of Boroughs or other Districts in Home Counties.

SMALL-POX HOSPITAL PROVISION.

Local Government Board,
Whitehall, S.W.,
6th December, 1901.

SIR,

I am directed by the Local Government Board to refer to the present outbreak of small-pox in London, and to state that, in view of the fact that some cases have also occurred in the neighbourhood of the Metropolis, they think it right to draw the attention of the Council to the necessity of their being prepared to deal with any cases which may occur in their district.

The Board understand that the Managers of the Metropolitan Asylums District have received communications from the Councils of some districts outside London with regard to the reception in the hospitals of the Managers of small-pox patients from those districts, but the Board must point out that it does not form part of the duty of the Managers to deal with such cases, and also that the demands upon them in respect of their own district would generally render it impracticable that they should do so.

In these circumstances it is clear that the Council must rely in this matter upon arrangements made by themselves, either alone or in conjunction with other Councils; and, looking to the extreme importance of the immediate isolation of small-pox cases where the disease appears, the Board would urge upon the Council to make forthwith such arrangements as may be necessary to provide hospital accommodation for the treatment of any cases occurring in their district, if they have not already done so.

I am dierected to forward to the Council copies of a memorandum prepared by the Board's Medical Officer, with regard to the steps specially requisite to be taken in places where small-pox is prevalent. A copy should be given to each Medical Officer of Health and Inspector of Nuisances in the District.

I am, Sir,
Your obedient Servant,
S. B. PROVIS,
Secretary.

The Town Clerk, or the
Clerk to the District Council.

(No. 9).

Metropolitan Borough Councils.

NOTIFICATION OF CHICKEN-POX AND RE-VACCINATION OF SANITARY STAFF.

Local Government Board.
Whitehall, S.W.,
27th December, 1901.

SIR,

I am directed by the Local Government Board to state that they observe from Reports which they receive from Medical Officers of Health in connexion with the present outbreak of small-pox in and around London that cases of that disease not infrequently escape immediate detection owing to their being regarded merely as cases of chicken-pox.

As the failure to detect such cases promptly is fraught with considerable danger to the community on account of the consequent risk of small-pox being spread, the Board would suggest that the Borough Council should consider the desirability of at once taking steps to add chicken-pox, either temporarily or permanently, to the list of diseases at present required to be notified in the borough under the provisions of section 55 of the Public Health (London) Act, 1891, and of thus affording their Medical Officer of Health the means of detecting possible sources of small-pox infection which are at present disregarded and are therefore uncontrolled.

This has been done in some of the metropolitan boroughs and in many districts outside the Metropolis.

If the Council decide to adopt this suggestion it will be necessary that the requirements of section 56 of the Act should be carefully complied with.

The Board take this opportunity of stating that they understand that in several recent instances members of the sanitary staff of metropolitan boroughs, especially persons employed in the disinfection of infected dwellings and infected articles, have contracted small-pox. The Board would point out that it is very desirable that any officer employed by the Council who is in any way to come in close relation with persons or articles infected with small-pox should first be protected by being effectively re-vaccinated.

I am, Sir,
Your obedient Servant,
S. B. PROVIS,
Secretary.

No. 18.

APP. A, No. 18.

Summary of the Progress and Diffusion of Bubonic Plague in 1901; by Dr. Bruce Low.

SUMMARY of the PROGRESS and DIFFUSION of BUBONIC PLAGUE in 1901; by Dr. R. BRUCE LOW.

This brief sketch of the progress and diffusion of plague throughout the world, during 1901, has been prepared in continuation of previous summaries published in the Medical Officer's Annual Reports.

In India, during 1901, there was, as compared with 1900, a remarkable increase of plague, the recorded number of attacks and deaths having been trebled. This may have been due in part to the extension of the disease to localities and provinces which had hitherto escaped; but there is ground for suspicion that part, at least, of the increase may be accounted for by the more complete notification of cases and deaths. These are not now concealed so much as formerly, the removal of many of the restrictive measures which were previously imposed having induced the native population to change their policy of opposition and concealment.

China, like India, has continued to suffer from epidemic plague, but the methods of recording epidemics in that country prevent definite information being obtained except in certain places such as Hong Kong, where in 1901 the annual outbreak was of a more severe kind than in 1900. In Formosa the number of plague attacks and deaths was quadrupled as compared with 1900.

Europe practically escaped a visitation of plague, though here and there imported cases occurred at certain ports, notably at Marseilles and Hull. Some indigenous cases, though not in any large number, occurred at Constantinople, Naples, Smyrna, Odessa, Liverpool, Glasgow, and Cardiff.

Plague was epidemic in South Africa during 1901, and again in Mauritius. Other outbreaks of greater or less severity were reported from Egypt, Arabia, Persia, Mozambique, Réunion, the Straits Settlements, Siam, the Philippine Islands, New Caledonia, Australia, the Sandwich Islands, California, Brazil, and the Argentine. Short details of these plague occurrences are given below.

INDIA.

Up to the end of 1900 the total plague cases reported in India since the beginning of the outbreak of the disease in 1896 amounted to 514,447, and the certified plague deaths to 403,671. During 1901, so far as can be gathered from the weekly official returns sent to this country from India, the total plague attacks numbered 362,750 and the deaths 278,748, making a total for the six years, 1896 to 1901, of 877,197 plague cases and 682,419 plague deaths. The following table shows the number of attacks and deaths from plague in each of the last six years; no account

however being taken here of untraced or concealed cases, which it is estimated must have amounted to many thousands :—

Year.	Plague attacks.	Plague deaths.	Case mortality per cent.
1896	2,980	2,288	76·7
1897	73,655	55,548	75·4
1898	151,640	117,733	77·6
1899	176,155	135,996	77·3
1900	110,017	92,106	83·7
1901	362,750	278,748	76·8
Total in six years ...	877,197	682,419	77·7

The enormous increase of plague in India was associated with the epidemic prevalence of the disease in fresh centres, but it has to be admitted that even in the districts invaded in previous years there was marked increase in the incidence of the malady. It has been recorded that in 1900 the Government of India ordered the relaxation of the plague preventive measures in view of the general hostility displayed by the native population. This relaxation was ordered at a time when plague seemed to be on the wane. It was at this time admitted by the Indian officials that heroic measures, while proving costly and irritating to the native prejudices, had not proved successful. How far this relaxation begun in 1900 affected the enormous development of the disease in 1901, it is impossible at present to say.

The following table shows the distribution of plague throughout the chief Provinces and Native States of India during 1901 :—

TABLE showing the Provinces and States of India which suffered from plague during 1901; their area, population, number of plague attacks and deaths, and the case mortality.

Provinces.	Area in square miles.	Population, 1901.	Plague attacks.	Plague deaths.	Case mortality per cent.
The Presidency of Bombay (including the Native States).	188,745	25,424,235	207,387	157,552	75·9
The Presidency of Bengal	189,837	78,493,410	90,762	78,629	86·6
The Presidency of Madras	143,221	38,623,066	3,686	2,819	76·5
The United Provinces of Agra and Oudh.	112,243	48,493,879	9,036	8,595	95·1

App. A, No. 18.

Summary of the Progress and Diffusion of Bubonic Plague in 1901; by Dr. Bruce Low.

TABLE showing the Provinces and States of India which suffered from plague during 1901, their area, population, number of plague attacks and deaths, and the case mortality—*continued.*

Provinces.	Area in square miles.	Population, 1901.	Plague attacks.	Plague deaths.	Case mortality per cent.
The Punjaub and Native States ..	133,741	24,754,731	31,516	16,668	52·8
The Central Provinces..	115,894	11,873,029	11	9	81·8
The Hyderabad State	82,698	11,174,897	139	95	75·5
The Mysore State	27,936	5,538,482	17,124	12,602	73·5
Rajputana	128,917	9,841,765	255	184	72·1
Kashmir	80,900	2,906,173	2,834	1,595	56·2
Total	—	—	362,750	278,748	76·0

THE PRESIDENCY OF BOMBAY.

It was at one time expected that the marked decrease of plague in the Presidency during 1900 would be maintained in 1901. But these anticipations were not realised, for 1901 saw a greater mortality from plague than any of the five previous years. The total number of recorded plague deaths in 1900 was only 33,196, whereas the total for 1901 amounted to 128,259 (including the City of Bombay but not including the Native States associated with this Presidency); and while only 587 towns and villages suffered from plague in 1900 no fewer than 1,582 were attacked during 1901. The incidence of the disease followed much the same course as in previous years, October showing for the Presidency as a whole the height of the epidemic. The Collectorates which suffered the most were Belgaum, Dharwar, Satara, and, as before, the City of Bombay. In a lesser degree Karachi, Broach, Surat, Poona, and Thana also were affected. The appended table gives the incidence of plague mortality month by month during 1901 in each of the 24 Collectorates into which the Bombay Presidency is divided. It will be seen that only three Collectorates, all situated in Sind, escaped plague-death during the year.

From the weekly summaries telegraphed from India to the India Office it appears that the total *attacks* in the Bombay Presidency, including the City of Bombay, amounted to 164,342, with an additional 45,045 in the Native States associated with the Presidency, a grand total of 207,387 cases. As these weekly summaries of attacks are subject to amendment and revision, it is certain that the aggregate of plague attacks which actually occurred exceeded even this large amount.

APP. A, No. 18.

Summary of the Progress and Diffusion of Bubonic Plague in 1901; by Dr. Brucb Low.

TABLE showing recorded Plague DEATHS in each of the Collectorate Districts of the Bombay Presidency month by month during 1901.

Registration District.	Collectorate.	Population, 1901.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Total in 1901.
Western Registration District.	Khandesh	1,427,382	—	43	380	103	12	1	—	—	85	388	639	975	2,676
	Nasik	816,504	7	19	16	1	—	—	1	—	7	91	313	231	686
	Thana	811,433	203	539	758	380	345	62	115	284	332	146	116	113	3,393
	City of Bombay ..	776,006	1,606	3,846	4,675	2,453	1,151	312	431	881	1,045	788	775	731	18,694
	Kolaba	605,566	17	54	129	55	30	33	114	214	184	127	86	73	1,116
Central Registration District.	Ahmednagar	837,695	—	—	—	—	—	—	1	—	—	1	9	9	20
	Poona	995,330	43	40	54	21	11	4	9	73	317	781	1,281	1 624	4,258
	Sholapur	720,977	—	—	—	—	—	—	2	25	41	100	62	57	287
	Satara	1,146,559	35	28	12	6	10	7	241	1,411	4,330	6,215	5,366	4,414	22,075
	Ratnagiri..	1,167,927	2	6	9	28	86	15	14	4	10	5	11	67	257
Southern Registration District.	Belgaum	993,976	499	869	889	358	492	1,047	2,017	2,761	5,263	8,467	6.594	4,547	33,803
	Dharwar	1,113 298	100	155	229	183	315	655	1,959	4,776	7,054	7,094	5,373	3,984	31,877
	Bijapur	735,435	—	—	—	—	—	—	1	3	5	3	—	30	42
	Kanara	454,490	3	14	7	—	7	11	9	78	191	30	69	108	527
Gujarat Registration District.	Surat	637,017	67	125	145	120	127	93	207	501	380	324	506	400	2,994
	Broach	291,763	—	—	—	—	—	—	—	27	640	446	392	393	1,898
	Kaira	716,332	—	2	4	2	1	—	3	—	4	111	116	126	369
	Panch Mahals	261,020	—	—	—	—	1	—	—	—	—	—	—	—	1
	Ahmedabad	795,967	4	12	121	13	4	—	—	—	—	—	2	—	156
Sind Registration District..	Karachi	446,513	1	80	570	1,065	753	52	10	19	37	76	211	227	3,101
	Hyderabad	989,030	—	—	2	24	—	—	1	—	—	—	—	—	27
	Thar and Parkar ..	363,894	—	—	—	—	—	—	—	—	—	—	—	—	—
	Larkhana	656,083	—	—	—	—	—	—	—	—	—	—	—	—	—
	Shikarpur	523,345	—	—	—	2	—	—	—	—	—	—	—	—	2
	Upper Sind Frontier..	232,045	—	—	—	—	—	—	—	—	—	—	—	—	—
Totals		18,515,587	2,587	5,832	8,000	4,814	3,345	2,291	5,135	11,067	19,926	25,193	21,971	18,109	128,259

App. A, No. 18.

Summary of the Progress and Diffusion of Bubonic Plague in 1901: by Dr. Bruce Low.

The *City of Bombay* (population at the Census of 1901, 776,006).—Though plague has prevailed, with seasonal exacerbations, in Bombay since the autumn of 1896, the disease shows no signs of diminution, notwithstanding vigorous efforts on the part of the authorities to suppress it.

The deaths from plague in 1899 and 1900 were 15,760 and 13,345 respectively. In 1901 the number rose to 18,694,* while the notified attacks amounted to 20,885. This gives a case mortality of 89·5 per cent. The height of the epidemic was reached in the third week of March, and the smallest number of notified cases was recorded in the last week in June. The following tabular statement gives approximately, so far as can be learned from the weekly summaries telegraphed to the India Office, the incidence month by month of plague in the city during 1901 :—

—	1901.												Total in 1901.
	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	
Plague attacks notified.	2,124	4,477	4,825	2,787	1,583	325	401	867	891	618	1,049	938	20,885

During the year an important step was taken as to plague administration in Bombay. The control of all plague operations and establishments was transferred to the hands of the Medical Officer of Health for the city. These powers were previously vested by Government in the Personal Assistant to the Commissioner, a military officer. No radical changes, however, were made in the policy of administration, the transfer being regarded as a step towards amalgamating the control of all epidemic diseases under the officials of the Town Health Department. The chief measures employed in Bombay during the year for combating plague were evacution of invaded houses, and the placing of contacts in camps, and the thorough disinfection of the infected rooms by means of washing them down with perchloride of mercury and phenyle. Compulsory removal to hospital was not enforced, and great care was exercised to avoid hurting the feelings and prejudices of the people. It was hoped that it would be found possible to gradually press for strict isolation of the sick. A scheme was prepared and laid before the Corporation and the Government for a better system of registration of deaths, notification of infectious sickness, and medical relief for the poor. The people in Bombay have, however, grown so habituated to the presence of plague that they remain callous as to its ravages. From official sources it appears that from September, 1896, to the end of December, 1901, close upon

* Another account issued by the Bombay Board of Health gives the actual attacks at 21,199 and the deaths as 18,891, a case mortality of 88·1.

79,000 victims are certified to have perished from plague in the City of Bombay; and that, of the six years during which plague has been epidemic in Bombay, the year 1901 shows the largest number of plague deaths, viz., 18,694, the next most fatal year being 1898. The table below gives the number of attacks and deaths officially recorded in Bombay City during each of the last six years:— App. A, No. 18. Summary of the Progress and Diffusion of Bubonic Plague in 1901; by Dr. Bruce Low.

Year.	Attacks.	Deaths.	Case mortality per cent.
1896	2,544	1,936	76·1
1897	13,314	11,003	82·6
1898	19,863	18,130	91·2
1899	19,454	15,874	81·6
1900	17,915	13,247	73·9
1901	20,885	18,694	89·5
Total	93,975	78,884	83·9

It is more than probable that these figures do not by any means represent the full incidence of plague on Bombay. Concealment of cases was common, and plague deaths not unfrequently were, knowingly or unknowingly, attributed to various other causes.

The Port of Bombay.—During 1901 88,306 vessels entered or left this port. Of these 34,637 were inspected, and the number of persons examined, including the crews of these vessels, amounted to 886,310. Out of this number 73 were found to be suffering from plague, 19 of them on board native craft lying in the harbour. As is well-known there is a very careful and thorough medical inspection of all persons leaving the Port of Bombay on board ocean-going vessels. Only five instances were recorded during 1901 where plague or suspected plague developed on board a vessel after she had left Bombay. These cases were :—

(1.) The s.s. *Bermuda*, which sailed for China on January 17th. Three days later one of the passengers developed plague, of which he died next day.

(2.) The s.s. *Assyrian* left on March 7th. At Karachi one of the passengers was found to be suffering from plague.

(3.) The s.s. *Paramatta* left on October 12th for the Far East viâ Colombo. One of the crew is reported to have died from what was regarded as plague off Colombo.

(4.) The s.s. *Peninsular* left on November 2nd, and landed at Marseilles two of her crew reported to be suffering from plague. (As to this ship, *see* page 314.) The

Port Medical Officer of Health for Bombay states that from inquiries he has made he is satisfied that there were not sufficient grounds for supposing that these two men ever had plague. Both patients made good recoveries.

(5.) The s.s. *Patiala* left on November 26th for Aden and East Africa viâ Karachi. A fatal case of plague occurred on board before the vessel reached Aden. The passengers had been allowed on shore at Karachi, at the time infected by plague. As the illness developed eight days after leaving Bombay, it is believed the infection was contracted at Karachi.

The subjoined table shows the amount of ship inspection in regard of plague at the Port of Bombay during the last six years:—

Year.	Vessels examined.	Crews and passengers inspected.	Number of persons found with plague.
1897	72,808	1,313,117	169
1898	71,498	1,207,571	236
1899	65,822	1,193,339	155
1900	65,966	1,173,050	84
1901	34 637*	886,310*	73

Native States associated with the Bombay Presidency.—During 1901 the total number of plague attacks officially reported in these Native States amounted to 43,045, and of these 29,293 proved fatal, a case mortality of 68 per cent. A large proportion of these cases and deaths were referred to Kolhapur, in which State 35,433 cases and 23,878 deaths were reported. Probably this was due to the extension of the epidemic of plague from the adjoining Collectorate of Belgaum, in which 33,803 plague deaths were certified during the year, the largest number in any Collectorate in the Presidency.

The appended table shows the incidence of the epidemic on each of the Native States month by month during 1901. The figures in the table have been compiled from the weekly summaries telegraphed from the Governor to the India Office. It is possible that later reports may show larger numbers than are here given.

* Major Crimmin, V.C., I.M.S., Health Officer for the Port, accounts for the decrease in the number of vessels and persons inspected by the fact that vessels sailing from the Port of Bombay for ports on the coast of the Kolaba district as far south as Roha were exempt from medical inspection in accordance with the Government Notifications of April 17th and September 30th, 1901.

PLAGUE in 1901 in the Native States associated with the Presidency of Bombay.

1901.	Kathiawar. Population, 2,329,196.		Cutch. Population, 488,022.		Kolhapur. Population, 910,011.		Baroda. Population, 644,071.		Janjira. Population, 85,414.		Darampur. Population, 20,530.		Savanur. Population, 18,446.		Aundh. Population, 63,921.		Sachin. Population, 20,530.		Savantvadi. Population, 217,732.		Rewa Kantha. Population, 479,065.		Jath. Population, 68,665.		Total for 1901	
	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.
January	221	121	15	10	377	264	77	37	17	14	—	—	—	—	—	—	—	—	—	—	—	—	—	—	707	446
February ..	212	117	54	40	520	339	116	87	57	46	—	—	—	—	—	—	—	—	—	—	—	—	—	—	959	629
March	151	84	230	178	499	368	119	83	107	89	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1,106	802
April	105	60	508	390	295	230	74	48	98	90	10	8	—	—	—	—	—	—	—	—	—	—	—	—	1,065	826
May	31	24	294	277	334	242	25	14	28	22	1	—	—	—	—	—	—	—	—	—	—	—	—	—	713	579
June	9	5	99	64	345	229	30	14	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	483	332
July	5	6	66	43	1,311	1,074	24	18	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1,406	1,141
August	6	1	332	264	3,745	2,820	63	39	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	4,146	3,114
September ..	148	99	393	286	7,067	4,832	90	57	—	—	—	—	30	11	72	42	9	9	—	—	—	—	—	—	7,809	5,336
October	264	223	223	179	8,640	5,069	229	140	—	—	—	—	40	17	474	276	40	23	1	1	—	—	—	—	9,911	5,948
November ..	151	107	287	226	7,886	5,324	346	245	—	—	—	—	171	121	463	350	34	24	—	—	20	5	—	—	9,358	6,402
December ..	31	22	191	183	4,414	3,067	363	166	6	3	—	—	269	206	145	79	5	3	—	—	35	26	3	3	5,362	3,738
Totals ..	1,334	869	2,687	2,180	35,433	23,878	1,456	948	313	264	11	8	510	355	1,154	747	88	59	1	1	55	31	3	3	43,045	29,293

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Summary of the Progress and Diffusion of Bubonic Plague in 1901: by Dr. Bruce Low.

Bengal Presidency.

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Summary of the Progress and Diffusion of Bubonic Plague in 1901; by Dr. Bruce Low.

There was a marked increase in the prevalence of plague in this province during 1901. Altogether, excluding the City of Calcutta, the figures for which are given further on, there were reported 82,151 cases of plague, 70,746 of which proved fatal, a case mortality of 86·11 per cent. This high fatality suggests that a considerable number of attacks were not reported; that it was chiefly the severe and fatal cases that came under observation. In 1900 the numbers were 31,472 attacks and 30,134 deaths. The amount of the disease in 1901 was therefore considerably more than double that of 1900. The districts which suffered most during 1901 were Patna, Saran, Gaya, Monghyr, and Darbhanga. The disease appears to have spread mainly along trade routes, and to have made but slow progress in the purely agricultural portions of the districts. The chief virulence of the malady was experienced during the winter months and reached its height in March. Afterwards it subsided during the hot and rainy months, but again showed activity from September onwards. The three main measures employed to combat plague in this Presidency were (*a*) evacuation of infected houses, (*b*) disinfection, and (*c*) antiplague inoculation. The appended table shows the incidence of plague during 1901 in the affected districts of the Bengal Presidency (exclusive of Calcutta).

Plague in the Bengal Districts during 1901.

Districts.	Population, 1901.	Plague attacks.	Plague deaths.
Burdwan	1,532,475	3	3
Midnapur	2,789,114	9	8
Hooghly	1,049,282	61	57
Howrah	850,514	213	183
24 Parganas	2,078,359	101	94
Nadia	1,667,491	7	7
Darjeeling	249,117	2	1
Rangpur	2,154,181	1	1
Dacca	2,649,522	1	1
Faridpur	1,937,646	2	2
Tipera	2,117,991	1	1

PLAGUE in the Bengal Districts during 1901—*continued.*

Districts.	Population, 1901.	Plague attacks.	Plague deaths.
Patna	1,624,985	31,804	27,403
Gaya	2,059,933	11,342	10,790
Shahabad	1,962,696	5,688	5,081
Saran	2,409,509	21,804	17,107
Muzaffarpur	2,754,790	1,304	1,265
Darbhanga...	2,912,611	2,705	2,532
Monghyr	2,068,804	5,305	4,742
Bhagalpur...	2,088,953	61	50
Purnea	1,874,794	1	1
Sonthal Parganas	1,809,737	274	219
Cuttack	2,062,758	21	21
Balasore	1,071,197	2	2
Hazaribagh	1,177,961	1,100	878
Palaman	619,600	185	168
Manbhum	1,301,364	154	129
Total during 1901	—	82,151	70,746

In the remaining 19 districts no plague, so far at least as is known, occurred.

During 1901 1,120,502 persons were examined at the plague observation camps and stations, and 674 were detained; of these 45 persons died from illness of one or another kind, but only 23 from plague.

Calcutta.—During 1901 there were recorded in Calcutta 8,611 cases of plague and 7,883 deaths from the disease, a case mortality of 91·54 per cent. In 1900 the numbers were respectively 8,822 and 8,278, the case mortality being 93·83. The fatality here recorded is higher than that reported in the rest of the Presidency.

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Summary of the Progress and Diffusion of Bubonic Plague in 1901; by Dr. Bruce Low.

The following table shows the distribution in Calcutta of the cases and deaths month by month throughout the year :—

—	1901.												Total in 1901.
	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	
Reported—													
Plague attacks	211	1,034	4,366	1,977	420	109	62	90	62	81	93	106	8,611
Plague deaths	204	934	3,810	1,919	401	130	61	86	61	79	93	105	7,883

The carrying out of plague preventive measures in Calcutta was entrusted to a special plague medical officer, Major Deane, R.A.M.C. Great reliance was placed by him upon thorough disinfection of houses; and he has expressed the opinion that a plague infected room can be rendered safe for immediate occupation by efficient disinfection. In dealing with the question of rat infection, Major Deane considers that rats have practically no concern with plague in Calcutta. He further states that "the recorded evidence dealing with the Bombay Presidency and Calcutta suggests that rats certainly are *not* the chief disseminators of infection."*

At the Port of Calcutta 108 vessels were examined, by the Port Medical Officer of Health, on arrival from such plague infected ports as Bombay, Karachi, Hong Kong, Port Louis, &c. No case of plague was found on any of them; but in four instances there was suspicion that the ship had been infected, and consequently the necessary disinfection was undertaken.

MADRAS PRESIDENCY.

It may be remembered that the incidence of plague upon this Presidency in 1900 was comparatively insignificient, only 915 attacks and 685 deaths being recorded in a population of over 38 millions. But in 1901 there was a marked increase in the amount of plague in the Presidency, 3,686 cases and 2,819 deaths being reported, the case mortality being 76·4 per cent. The following table shows the progress of the disease throughout the year month by month :—

—	1901.												Total in 1901.
	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	
Reported—													
Plague attacks	234	618	365	211	42	35	34	80	97	156	536	1,379	3,686
Plague deaths	157	398	286	157	28	26	20	50	63	112	412	1,110	2,819

* Vide "Indian Medical Gazette," October 1901, page 386.

The increase of prevalence at the end of 1901 was followed by a very considerable development of the disease in the earlier part of 1902.

The majority of the cases in 1901 were referred to the districts of Salem, Bellary, and North Arcot, the infection no doubt having been brought by persons returning from the Kolar gold fields in Mysore State where plague was prevalent.

In the the City of Madras, with a population of 506,346, only nine plague cases occurred throughout the year. In none of the six years since plague became epidemic in India has the City of Madras suffered from the malady, except in the form of a few imported cases.

United Provinces of Agra and Oudh.

Comparatively little had been heard during 1900 of plague in these Provinces. In the earlier months of that year some 162 cases and 128 deaths from the disease were reported. But there was freedom from plague from May to December. In January, 1901, the disease began again to manifest itself, and in April the epidemic reached its height, rapidly subsiding in May and June, and disappearing altogether in July and August. There was a recrudescence in September onwards to the close of the year, and the epidemic extended into the early months of 1902. The following table shows the progress of plague in 1901 in the United Provinces :—

—	1901.												Total in 1901.
	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	
Reported—													
Plague attacks	7	224	1,991	4,316	847	24	—	—	50	189	385	1,003	9,036
Plague deaths	5	193	1,858	4,180	821	32	—	—	48	174	324	960	8,595

The case mortality rate was 95·1 per cent., and from this it may be inferred that all the attacks were not reported, and that mostly the severe and the fatal cases came under observation, the milder cases being concealed. The chief districts which suffered during 1901 were Benares, Ballia, Allahabad, and Jaunpur.

The Punjaub.

During 1901 there was a notable increase of plague in the Punjaub, no fewer than 14,959 deaths being recorded (including the Native States the total plague deaths were 17,002). These

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deaths were distributed over the various districts, as follows, the figures for the previous year being given for purposes of comparison:—

Districts.	Population, 1901.	Plague deaths.	
		1900.	1901.
Jullundur	904,307	417	3,857
Hoshiapur	989,782	43	2,308
Gurdaspur	936,784	35	4,325
Sialkot	1,071,327	—	3,695
Ludhiana	673,097	—	429
Lahore	1,146,029	—	180
Umballa	763,250	—	154
Ferozpore	932,206	—	8
Amritsar	1,022,438	—	1
Gurjanwala	890,577	—	1
Jhelum	590,770	—	1
	—	495	14,959

It appears from a report by Lieut.-Col. J. C. Bamber, I.M.S., Sanitary Commissioner for the Punjaub, that of the above 14,959 deaths 8,916 were females and 6,043 males. This special fatal incidence on women, he considers, is partly accounted for by the indoor life led by women. The houses are generally small and dirty and ill-ventilated; when such houses are invaded by plague the female inmates leading secluded indoor lives are more prone to contract the disease. Lieut.-Col. Bamber regards the malady as having been mainly spread by human intercourse, or by infected articles of clothing. In no instance could proof be obtained of the infection having been introduced by rats, though in many villages it is alleged that large numbers of dead rats were observed before the disease had become severely epidemic.

From the weekly summaries telegraphed to the India Office it appears that the total *attacks* in the Punjaub recorded during the year amounted to 29,180 (not including those referred to the Native States).

Native States associated with the Punjaub.—The Native States of Patiala, Kapurthala, and Nabha, which are assoicated with the

Punjaub also suffered from plague during 1901. So far as can be ascertained the following was the total number of attacks and deaths reported during the year :—

—	Population in 1901.	Plague.	
		Attacks.	Deaths.
Kapurthala State	314,851	968	747
Patiala State...	1,596,692	1,328	939
Nabha State	297,949	31	23
Total	—	2,327	1,709

The Central Provinces.

The amount of plague in the Central Provinces has not been great in any year since plague invaded India in 1896. In 1898, 1899, and 1900 the deaths from plague officially recorded numbered respectively 131, 526, and 607. In 1901 only a few scattered cases and deaths came under notice—11 attacks in all, nine of them fatal. So that the Central Provinces with its population of nearly 12 millions practically escaped during 1901 the ravages of plague.

The Hyderabad State.

This State, it will be remembered, was infected by plague at the end of 1897. In the three years 1898, 1899, and 1900 the plague deaths reported were respectively 3,868, 6,378, and 938. In 1901 only 95 deaths from plague were officially certified, the number of notified cases being 139. These cases and deaths occurred in the two districts of Aurangabad and Linsagur. No less than 95 attacks and 55 deaths were referred to the month of December, the disease becoming more seriously epidemic in the earlier months of 1902.

The Mysore State.

This State has been suffering from plague since 1898, the deaths from the disease in the three years 1898, 1899, and 1900 having numbered respectively 5,335, 10,810, and 12,987. In 1901 the plague deaths amounted to 12,602. So that the malady maintained its hold upon the State, a condition of affairs which unfortunately became more pronounced in 1902.

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The number of attacks and deaths in Mysore in each month during 1901 is given in tabular form below* :—

—	1901.												Total in 1901
	January.	February.	March.	April.	May.	June.	July	August.	September.	October.	November.	December.	
Reported—													
Plague attacks	2,505	1,295	879	452	143	418	736	1,540	1,785	2,007	2,964	2,400	17,124
Plague deaths	1,825	1,000	693	354	120	277	537	1,068	1,304	1,463	2,163	1,798	12,602

The case mortality was 73·6 per cent.

RAJPUTANA.

In Rajputana during 1900 only 19 plague attacks and 14 deaths were recorded. But in 1901 255 cases, 184 fatal, came under observation. These cases were chiefly confined to the Marwar State, and the bulk of them occurred during March and April.

KASHMIR.

In the Jammu district, on the Sialkot border, plague tended to be epidemic during April, May, and June, 1901, disappearing almost altogether during July, August, and September, but recommencing with some virulence in October, November, and December. The total plague attacks recorded amounted to 2,834 and the deaths to 1,595. The following tabular statement shows the incidence of the disease throughout 1901 :—

—	1901.												Total in 1901.
	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	
Reported—													
Plague attacks	—	2	13	117	206	106	2	2	11	95	981	1,299	2,834
Plague deaths	—	—	7	83	148	65	2	1	8	55	502	724	1,595

The case mortality was 53·2 per cent.

The epidemic in progress in Kashmir at the end of 1901 continued with some virulence during the first five mouths of 1902.

* This table has been compiled from the weekly summaries telegraphed from India to the India Office.

Burma.

During 1901 no indigenous plague cases were reported in Burma. But at the Port of Rangoon five suspicious cases, all ship-borne, three of them fatal, came under observation. In none of these cases was the diagnosis of plague confirmed.

CHINA.

Plague was again prevalent in Southern China during 1901, especially in the Province of Kwang-Tung. This prevalence has been referred to trade communications with the plague epidemic centre of Hong Kong, from which sick Chinamen fled to the mainland as soon as they began to feel ill, in this way spreading the disease. It is stated that frequently plague patients were landed from the Hong Kong steamers at Canton and other ports. From Canton the disease is said to have spread inland along the course of the navigable waters, especially up the West River.

Plague also appeared in the Island of Hainan, off the south coast of China, and devastated a number of towns and villages. The disease also became epidemic in North China, at Newchwang, where plague has in former years shown itself epidemically.

A brief summary of the main outbreaks, as far at least as information as to them could be obtained, is given below.

Hong Kong (population estimated to middle of 1901, 300,660).—Once again Hong Kong experienced a plague epidemic, and on this occasion in increased amount, compared with the previous outbreaks, except that of 1894. For purposes of comparison the numbers of cases and deaths during each of the previous years are given below :—

—	1894.	1895.	1896.	1897.	1898.	1899.	1900.	1901.	Total in 8 years.
Recorded—									
Plague attacks	2,833	45	1,204	21	1,320	1,486	1,087	1,651	9,647
Plague deaths	2,550	36	1,078	18	1,175	1,415	1,030	1,562	8,864
Case mortality per cent.	90·0	80·0	89·0	85·7	89·0	95·0	94·7	94·6	91·8

It is well understood that these numbers, whether in the previous years or in 1901, do not represent by any means the actual amount of plague which occurred in Hong Kong. The facilities for sick Chinamen leaving Hong Kong were such that large numbers as soon as they began to feel ill made for the mainland seekng their native towns or villages. In addition the usual concealment of cases and of deaths was carried out in cunning ways contrived by oriental ingenuity.

App. A, No. 18.

Summary of the Progress and Diffusion of Bubonic Plague in 1901; by Dr. Bruce Low.

The distribution month by month, of the 1,651 plague cases which were reported in Hong Kong during 1901 is shown below:—

—	1901.												Total for 1901.
	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	
Plague cases ..	7	17	67	200	665	576	71	26	19	1	—	2	1,651

Of the 1,651 reported attacks all but 89 were fatal, *i.e.*, there were 1,562 deaths, a case mortality of 94·6 per cent.; 910 of these persons were found dead. There is a good deal of overcrowding in Hong Kong, and considerable intercommunication with other towns and ports in Southern China, whence plague infection is liable at times to be brought to Hong Kong, while at other periods when the disease becomes epidemic in the Colony it is liable, as has been said, to be exported therefrom to other places. In view of the annually recurring epidemics of plague in Hong Kong, the Governor obtained, with the assistance of the Colonial Office, the services of two experts to enquire into the sanitary condition of the Colony. These experts, Professor W. J. Simpson, M.D. (formerly Medical Officer of Health for Calcutta, and lately plague consulting expert to the Government of Cape Colony), and Mr. O. Chadwick, C.M.G., a skilled engineer, visited Hong Kong in the early part of 1902 and made certain recommendations which it is hoped, if duly carried out, will prove of service to the Colony in reducing its liability to outbreaks of plague.

As showing the enormous shipping communications between Hong Kong and other ports it may be mentioned that in the year 1901, 46,201 ships entered the port, viz.:—

—	Ships.	Tonnage.
British	6,715	9,213,639
Foreign	4,092	5,345,502
Junks in foreign trade ...	35,394	3,266,168
Total	46,201	17,825,309

The above does not include junks engaged in local trade.

Canton District.—During 1901 plague reappeared in the City of Canton, and in the neighbouring towns and villages. In

Canton itself plague began to prevail in February, but, as the Chinese authorities were averse to giving any information as to the real state of the epidemic, no precise figures can be given respecting plague cases and deaths, though it was reported on the authority of the United States Consul that nearly 100 plague deaths were occurring daily in the middle of May. By August the disease had almost entirely disappeared.

San Tong, a small town with about 13,000 inhabitants, in the Canton district, suffered heavily from plague during 1901. It is asserted that during the first five months of the year no fewer than 1,200 persons perished here from plague.

Other towns and villages in the Canton District also suffered but no details have been received.

Swatow District.—During the spring of 1901 plague again became epidemic in Swatow and in the surrounding district, some of the smaller towns and villages of which are reported to have lost about a fourth of their population from plague. Many villages were entirely deserted, the inhabitants having fled from their homes to the hills, or taken refuge on boats on the river. The epidemic during 1901 was much severer in this district than any of recent years. It is said that the case mortality was as high as 95 per cent., but, as in other Chinese districts and towns, exact statistics of epidemics are not obtainable. In some places the deserted homes were ransacked systematically by organised bands of thieves and the plunder conveyed away for sale in adjoining towns.

No definite account of plague prevalence in the city and port of Swatow has been obtained, though it is known that plague had been prevalent there. In an official notification dated July 24th, 1901, "the district and port of Swatow" were declared "free from epidemic plague," and clean bills of health were authorised.

In the town of *Ung-Kung*, which has a population of about 40,000, and which lies near the coast, plague has been appearing intermittently since 1897. Early in 1901 the disease reappeared here in a virulent form. It is estimated from the records of the coffin makers that at least 4,000 persons, or 10 per cent. of the population, died from plague during the first half of 1901. The disease also raged in the villages around Ung-Kung.

Amoy.—In May, 1901, plague re-appeared in Amoy. Here, as elsewhere in China, it was impossible to form a true estimate of the extent of the outbreak owing to the absence of any statistics or records kept by the Chinese authorities. The United States Consul, however, stated that during the first fortnight of May some 325 deaths from plague came under notice. Some authorities estimated the mortality during the height of the epidemic as 100 per day. By the end of August the disease had subsided.

Hainan.—During 1900 the town of Hoihow had suffered severely from plague, but during 1901 it appears to have escaped the scourge. But other places in the island were attacked. For

example, the district and town of Dam Chian suffered for a period of six months in 1901 from epidemic plague. Some of the adjacent villages were deserted, the people having fled from the pestilence, which, however, they did not in many instances escape; some carried the disease with them, and acted as sources of infection for other districts.

Newchwang.—During August, 1901, plague broke out at Newchwang. In the previous year some 2,000 of the inhabitants were swept away by the scourge. The Russian authorities were in possession of the port of Newchwang during 1901, and the stringency of their measures to prevent the spread of plague defeated to some extent their object. Cases of illness were concealed and the bodies of the dead were smuggled out of the town, sometimes in bales of cotton or the like. So evident was it that the severity of the measures was doing mischief that the Russian authorities relaxed the regulations. Altogether up to December only 93 cases were reported, all of which except two proved fatal. This excessive fatality is strong evidence that cases were concealed. Only two Europeans suffered, namely, two Russian soldiers. It was generally believed that the 1901 plague outbreak at Newchwang was due to a re-importation of the disease and not to a recrudescence of infection remaining from the 1900 epidemic.

JAPAN.

During the first half of 1901 only seven recognised cases of plague, all of them fatal, came under notice in Japan, viz., two cases at Wakayama, not far from Osaka, where the disease had been epidemic at the end of 1900, and one case at Yamanashi, the infection it was stated having been probably imported. The remaining four cases were ship-borne, and of these three were brought to the port of Nagasaki and the other one to Kobe. The infection came in two cases from Hong Kong, and in the others from Keelung and Anping, in the island of Formosa.

In June, 1901, plague infected rats were discovered in the compound of the University of Tokio. It was generally believed that the infection of these rats had been derived from rats experimentally inoculated with plague in the bacteriological laboratory and which had escaped. Stringent measures were taken to enclose the compound and destroy every rat within it. Fortunately no human cases occurred. Plague infected rats were also found during July at Osaka, but no human epidemic followed.

FORMOSA.

(Estimated population 1891, 2,797,543.)

Plague has been more or less prevalent in the island of *Formosa* during the past six years, but the severity of the outbreak in 1901 exceeded that of any of the previous years, the total cases recorded during 1901 amounting to 4,519, and the deaths to 3,634, a case mortality of 80·4 per cent.

The following table gives a summary of plague attacks and deaths in Formosa during the six years 1896 to 1901 inclusive :—

APP. A, No. 18.

Summary of the Progress and Diffusion of Bubonic Plague in 1901; by Dr. Bruce Low.

Year.	Plague attacks.	Plague deaths.	Case mortality per cent.
1896	246	147	59·7
1897	730	566	77·5
1898	1,233	882	71·5
1899	2,637	1,994	75·6
1900	1,079	809	74·9
1901	4,519	3,634	80·4
Total in six years	10,444	8,032	76·9

The chief district in the island which suffered from the ravages of plague was Tainan, in which during the first half of 1901 as many as 2,661 cases and 2,059 deaths were recorded.

THE PHILIPPINES.

Plague broke out in *Manila* early in 1900, causing during that year 199 deaths. In November and December of that year it seemed to die out, but in January, 1901, cases began again to appear. The outbreak reached its height in April and May, practically subsiding towards the end of August, though cases and deaths continued from time to time to be reported up to the close of the year.

The following table shows the course of the epidemic in Manila month by month during 1901 :—

—	1901.												Total in 1901.
	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	
Plague attacks ..	5	26	60	107	152	54	37	40	11	6	1	9	508
Plague deaths ..	5	20	49	84	129	43	33	28	7	6	—	9	413

The case mortality during 1901 was 81·3 per cent.

From Manila a number of other places became infected, including Cavite, Cebu, Concepcion, Malolos, Malabon, Naic, Paranagra, San Antonio, Santa Rosa, &c. A small outbreak occurred in July among the American soldiers at Camp Stotsenburg, 15 miles from Manila, the infection having been contracted in that city. The troops were at once removed to a fresh camp, and the old barrack buildings were destroyed by fire.

As elsewhere, during the prevalence of plague in Manila plague infected rats were found, and a war of extermination was carried out against them. Of the rats taken to the bacteriologist for examination it is reported that 1·7 per cent. were found infected by plague.

STRAITS SETTLEMENTS.

Singapore.—During the first quarter of 1901 some nine cases of plague were reported in Singapore, eight of them fatal. It was alleged that other cases escaped observation, owing to the efforts of the natives who resented interference with their insanitary habits and conditions of life. Fortunately no extension of the disease occurred during the rest of the year.

Penang.—In December, 1901, a single suspected case of plague occurred in Penang, and died after two days' illness. No further cases, however, followed.

Perak.—At the town of Ipoh (population 12,791), in the State of Perak, a case of plague was reported in February, 1901, but no particulars as to it have been published.

Selangor.—In May, 1901, five cases of plague, followed by two others in July, were reported from the town of Kuala Lumpur (population 32,381), in Selangor. All seven cases were fatal. It is stated that about the time these cases appeared rats were found dead in the town, and upon bacterioscopic examination they were found "swarming" with plague bacilli.

SIAM.

In June it was reported that plague had broken out at *Tong-Kah*, and that up to July 2nd some 37 cases had been observed, with 21 deaths. But no further details of this outbreak have been received.

NEW CALEDONIA.

From French official reports it appears that in August, 1901, plague again appeared in *Noumea.* From August to October the total cases which came under observation numbered 36, and of these 11 were fatal. From other sources of information, however, statement is made that plague cases were appearing in Noumea in June and July, and some residents went so far as to assert that plague cases had continued to occur since April, 1900, when the outbreak of that year was said to have ceased.

AUSTRALIA.

NEW SOUTH WALES.

Sydney.—The epidemic of plague at Sydney in 1900 was practically over in July. In March, 1901, the s.s. *Antillian*, from the Cape, arrived at Sydney with a case of plague on board, in the person of one of the crew. He succumbed to the disease, and his case was followed shortly by another, which recovered. It was said that the man who was first attacked had been engaged, before arrival at Sydney, in cleaning out the hold, where some 15 dead rats had been found and thrown overboard. These dead rats were discovered after the ship left Albany, Western Australia, on her way to Sydney. The master of the vessel said that there were not many rats on board. On the occurrence of these two plague cases the authorities at Sydney caused a bacteriological examination to be made of the bodies of three rats obtained from the *Antillian*, with the result that the rats were declared infected by plague.

The vessel was placed in quarantine and disinfected. Special fumigations to destroy rats were carried out, and the ship sailed on April 6th with 527 men of the newly formed Australian contingent for South Africa. No further cases of plague occurred in connection with this vessel.

In November a young man engaged in a store at Sydney was attacked by plague, and it was at first asserted that no infection among rats infesting the store was discovered. Later, however, a statement appeared in the press that rats infected by plague had been found in the store in which the youth was employed. He made a good recovery. No further cases came under observation till December, when a second case was reported in one of the suburbs of Sydney. This patient succumbed within a few days, and the diagnosis of plague was bacterioscopically confirmed. It was stated in the press that dead rats had been found in the place where this man worked. These cases formed the commencement of a limited outbreak of plague which continued during the first half of 1902.

QUEENSLAND.

Brisbane.—Plague had appeared in Brisbane during 1900, but had apparently disappeared at the end of the year, the total attacks having been 56 and the deaths 24. Early in March, 1901, a single case occurred and this was followed shortly by three others. After this date scattered groups of cases came under observation up to the middle of August, the total plague attacks in Brisbane amounting to 34, of which 11 proved fatal. Some of those attacked lived in places situated in the immediate vicinity of Brisbane though not in the city itself.

While these scattered cases of plague were occurring in Brisbane it was stated there was serious illness rife among the aboriginals of Queensland and some suspicion arose as to plague. No official report on the epidemic ailment among the natives has been issued, and the real nature of the disease seems to remain unverified.

In October Queensland was declared free from plague, no cases having been reported for more than six weeks. In December, however, a fresh case occurred in Brisbane and was followed early in 1902 by others, the beginning of a fresh outbreak in Queensland.

Bundaberg lies on the River Burnett, 272 miles north of Brisbane. In April a single non-fatal case of plague, probably imported from Brisbane, occurred in that town, but was followed by no others.

Cairns is a town on the Queensland coast some 900 miles north-west of Brisbane. There had been a few plague cases in this town during the first half of 1900. In June, 1901, a single non-fatal case was reported. There was apparently no extension of the disease during the year.

Victoria.

Melbourne.—In the spring of 1900 a plague epidemic among rats was discovered on the wharves at Melbourne. During that year a few scattered cases of plague in the human subject were reported in the town and in its suburbs up to the month of May. After this nothing further was heard of plague till the beginning of March, 1901, when a single case came under observation. From this case, however, there was no extension of the disease.

South Australia.

Adelaide, the capital of South Australia, is situated on the Torrens River and is connected by railway with Port Adelaide. On February 28th, 1901, a suspected plague case occurred at Port Adelaide, the diagnosis being confirmed later on. The patient as well as his family were removed to Torrens Island to undergo observation. It may be remembered that eight plague cases, three of them fatal, as well as five suspected fatal plague cases, occurred in Adelaide during 1900, the last case being reported on August 11th of that year. The infection in the case above described was probably imported.

Western Australia.

Fremantle.—Plague appeared at this seaport, which is situated at the mouth of the Swan River, early in April, 1900. After some months' freedom from the disease two cases were again reported from Fremantle in March, 1901. It is stated that neither in 1900 or in 1901 were any plague infected rats found at Fremantle. The port remained free from the disease till the early summer of 1902, when a fresh group of cases came to the notice of the authorities.

Perth, the capital of Western Australia, is situated on the Swan River 12 miles from Fremantle. In May, 1900, plague was reported

at Perth, but there was no epidemic and the town and port remained free from infection till March, 1901. The disease then commencing did not subside till the beginning of May, but altogether only 16 cases, five of them fatal, were certified. At the time the earlier cases of plague occurred in 1901 at Perth, *i.e.*, in March, no evidence was found that rats were infected; but in April, it is said, rat infection became evident, apparently subsequent to the appearance of the disease in man.

Subiacò.—Two plague cases were reported from Subiaco in March, 1901, the infection having been derived from Perth. It is stated that no evidence of rats infected by plague could be discovered at this place.

Claremont.—In March, 1901, a plague case occurred at Claremont, and in May another attack was notified. Both cases recovered. The infection was believed to have been traced to Perth. No rats infected by plague were found at Claremont.

Kalgoorlie.—On April 14th a traveller, recently arrived at Kalgoorlie from Perth, was attacked by plague; he, however, made a good recovery and there was no extension of the infection to man or to rats.

On May 17th Western Australia was officially declared free from plague.

THE SANDWICH ISLANDS.

Honolulu.—In March, 1901, a Japanese woman employed as a nurse in a private family was removed to hospital suffering from a malady of which she quickly died, and which was afterwards diagnosed bacteriologically as plague. Another fatal case was reported at the end of May and two more, also fatal, early in June. During July two other cases which terminated fatally came under notice, the diagnosis in each instance being bacterioscopically confirmed. Investigation about July showed that rats were also suffering and dying from plague near houses in which patients had been attacked.

No further cases of plague came under notice till October, *i.e.*, after an interval of three months, when some dead rats were found on board the steamer *Waialeale* at Honolulu. Investigation showed that the animals had died from plague. The master said he had noticed dead rats for about three weeks on the ship, which plies between Honolulu and ports in the island of Kanai. No cases of illness had occurred among the crew, notwithstanding that the native sailors and labourers work on board barefooted.

In November plague once again showed itself, the first case, which was fatal, being reported on November 10th, from which date up to the end of December a total of 12 plague deaths were certified. During January, 1902, a further group of cases was reported.

Kanai.—Several plague cases, two of them fatal, occurred at Kealia, in the island of Kanai, at the beginning of November, 1901. The origin of these cases is obscure, but some persons attributed the infection to the steamer *Waialeale*, which, as mentioned above, trades between Honolulu and Kanai ports, and on which plague infected rats had been found a few weeks previous to the occurrence of the Kealia cases.

NORTH AMERICA.

THE UNITED STATES.

New York.—On July 22nd, 1901, the German steamer *Hohenfels* arrived at the port of New York from Calcutta. On arrival one of the crew, a Hindoo stoker, was found to be suffering from a mild attack of plague. The patient was isolated, and the crew were landed at Swinburn Island to undergo quarantine while measures were taken to disinfect the ship. There was no extension, and the man made a good recovery.

Utah.—During November, 1901, a death from plague occurred at Salt Lake City. No details have been made known as to the source of the infection.

Michigan.—In April, 1901, a medical student at Ann Arbour was reported to have contracted plague accidentally while conducting experiments with cultures of the bacillus pestis. These cultures, it appears, had been obtained from California, where, as will be seen further on, plague had been appearing.

CALIFORNIA.

San Diego.—On June 22nd, 1901, the British s.s. *Carlisle City*, with a Chinese crew and passengers, arrived at San Diego from Hong Kong *viâ* Yokohama, and reported that six deaths had occurred during the voyage. The vessel left Hong Kong on May 13th and sailed from Yokohama on May 29th. On June 6th a sailor cook became ill and died on June 9th, his death being attributed to jaundice. The ship touched at Honolulu on June 11th and left on June 13th. Next day a sailor became ill with fever and developed glandular swellings. On June 16th two other sailors were attacked with similar symptoms, and on the 18th a fourth fell ill. All of these four sailors succumbed. On the same day one of the passengers was suddenly attacked by illness of which he died after a few hours. The last of these six fatal cases (all Chinese) expired on June 21st, the day before reaching port. In all except the first of this series of cases the leading characters of the attack were fever, delirium, and glandular swellings. Though there was no bacterioscopic investigation there can be little doubt but that the illness in question was bubonic plague. No further cases was reported after the ship's arrival at San Diego, but one of the engineers showed some suspicious symptoms, including glandular enlargements and fever, before the vessel sailed on July 8th for San Francisco. He was detained at San Diego, and the medical report was to the effect

"that his illness was not dangerous," no information being given as to the nature of the indisposition. On the ship's arrival at San Diego all the crew and steerage passengers were injected with 10 cc. of Yersin's serum, and the upper cargo holds and cabins were fumigated with sulphur. The cargo was discharged into lighters, and afterwards the ship was further fumigated to destroy all rats. After completion of the process only 21 rats were collected, and all were examined bacterioscopically with negative results. Four of them were in a mummified state and could not be properly examined. It was stated that some dead rats had been found before the occurrence of the above group of cases on board the *Carlisle City*.

San Francisco.—Notwithstanding the many and strenuous denials of the State Board of Health of California, and notwithstanding the statements publicly made in September, 1901, by the Governor of the State that "San Francisco is and has been absolutely free from the disease, and that those who said it existed were either mistaken or deliberately misrepresented the facts," there cannot be the slightest doubt that plague has existed in San Francisco since March, 1900. During that year some 22 cases, all fatal, came to light, and in 1901 30 more were discovered, 26 of them fatal, the cases being mostly found in the Chinese quarter of the city. The distribution of these cases throughout the year is given below.

—	1901.												Total in 1901.
	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	
Plague cases ..	3	6	1	4	—	—	4	1	6	3	1	1	30
Plague deaths ..	3	6	1	4	—	—	3	1	4	3	1	—	26

The case mortality was 86·6 per cent.

It has been publicly stated that plague attacks and deaths have been concealed in San Francisco by means of a system of collusion between the State Health Authorities and the all powerful Chinese "Six Companies." According to the Sacramento *Bee* the arrangement was that cases of sickness among orientals were to be reported first to the "Six Companies," who would then report them to the State inspector, who in turn would report to the City Board of Health and to the United States Marine Hospital Service. It was alleged that plague cases or corpses were removed outside the city for treatment or for burial. The discreditable denials of the existence of plague in San Francisco and the scandalous concealment of suspicious sickness have produced throughout America a strong feeling of indignation, which has found vent in the public press and in resolutions carried at meetings of boards of health and of

sanitary associations. It may be mentioned that early in 1901, while the controversy about plague in San Francisco was at its height, the Legislature of California met, and the Secretary of State drafted a Bill making it a felony to print or publish or to make in writing a report of plague or cholera before the public announcement had been made by the State Board of Health.

On reference to the tabular statement above it will be seen that no cases or deaths were met with during the months of May and June. It appears that on July 2nd a Chinese undertaker mistaking one of the United States Marine Hospital Service staff for a State Board of Health official reported to him the case of a Chinaman in a moribund state. The surgeon in question called to his assistance other experts, clinical and bacteriological, and the case was found to be one of fatal plague. But the officials of the State Board disputed the diagnosis and ascribed the death to syphilis. During the same month three Japanese prostitutes living in a brothel frequented by Chinese died from plague, the diagnosis in each instance being confirmed by post mortem examination and by bacterioscopical investigation. Another prostitute from the same house was also attacked, but recovered.

From the above and from other evidence it is evident that the 30 cases given in the table do not by any means represent all the plague cases which have occurred at San Francisco during 1901.

BARBADOES.

The Norwegian barque *Hama* from Cape Town arrived at Barbadoes in ballast on March 25th, 1901. Two of her crew had suffered on the voyage from glandular swellings accompanied by fever. On examination at the date of arrival the enlargement of the glands was still visible though the fever had disappeared. As the cases afforded grounds for suspecting plague, the ship was disinfected and kept in quarantine till she sailed for Pensacola.

SOUTH AMERICA.

BRAZIL.

Rio de Janeiro.—During 1900 it is stated that about 292 deaths from plague were recorded in Rio de Janeiro. The epidemic of 1900 extended into the first three months of 1901, during which period 19 more fatal cases were reported. On March 10th Rio de Janeiro was officially declared to be free from plague, and no further suspicious cases were heard of till about the end of May when five new cases were certified as plague after bacteriological examination. It was alleged that these five new cases were in persons who had recently arrived from Portugal ; two of them were certified as *lymphatitis pernicioso*, and had come from Oporto. Three more deaths from so

called *lymphatitis* were certified during the third week of July, and during the fourth week of that month six more cases certified as plague, three of them fatal, were recorded. Besides these deaths there were a number of others classed as due to *accessio pernicioso*, a customary term applied to acute cases which could not be properly diagnosed, or which it was thought prudent not to diagnose more clearly, and which were generally believed by competent authorities at the time to be cases of plague. The number of cases reported as plague continued to increase in September, and the disease was constantly in evidence in the death returns up to the close of the year. It is not always easy to obtain regular and correct official returns of infectious sickness and death from South American Governments. But so far as can be learned from the sources of information available, there were reported from May to December during 1901 some 319 cases of plague with 135 deaths. In addition 49 were certified from *lymphatitis pernicioso*, which the authorities regarded as plague, making a total of 184 deaths due to the disease in the last six months of the year. It is worthy of mention that as soon as plague was officially recognised the number of deaths certified as *lymphatitis* suddenly became reduced, while the number ascribed to plague as suddenly increased. During the same period 116 deaths were certified as due to *accessio pernicioso*, most of which, it was believed, were caused in reality by plague. In September some deaths certified as due to septicæmia were suspected to be from plague.

A later report on mortality in Rio de Janeiro during 1901 gives the total certified deaths from plague as 164.

So far as can be ascertained the number of cases of plague reported each month during 1901 in Rio de Janeiro was as follows. The estimated population in 1901 was 793,000 :—

—	1901.												Total in 1901.
	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	
Reported plague attacks.	14	5	1	—	5	?	4	12	44	99	88	67	339

One of the Austrian Lloyd steamers, the *Gundulic*, arrived at the port of Rio de Janeiro on November 13th, 1901, from Trieste, which port she left on October 7th ; she called at Alexandria to load some cargo, but the crew were kept carefully from contact with the population on shore. The vessel left Alexandria on October 10th. During the voyage it is stated dead rats were found on board. On November 5th, the ship's cook was attacked by plague ; a steward also fell ill on November 6th. The first mentioned patient died on November 11th. The second case was taken

ashore on November 13th to the Rio de Janeiro port hospital. After undergoing quarantine and disinfection the *Gundulic* sailed for Santos on November 27th. On November 28th a stoker was taken ill with symptoms similar to the two others. Being refused pratique at Santos the ship returned to Rio de Janeiro, and on her way back a fourth member of the crew was attacked. These three last cases recovered. It is believed that the plague infection was received at Alexandria, and it has been suggested that plague infected rats brought the disease on board.

Campos, with a population of about 27,000, lies some 155 miles north-east of Rio de Janeiro. While plague was becoming epidemic at the latter place an outbreak was reported at Campos. The earliest cases were referred to the third week in September, and up to the end of December 221 plague cases and 96 deaths were recorded.

Petropolis is situated about 25 miles north-east of Rio de Janeiro. In October, 1900, there was a small outbreak of plague at Petropolis. At the end of 1901 another small group of cases was reported, three of them fatal; the infection, it is said, was brought from Rio de Janeiro.

Porto Alegre has a population estimated at about 73,000. It is situated on the coast some distance north of Rio de Janeiro. During October, 1901, a number of cases regarded by the medical profession of the city as true bubonic plague came under observation. The State Government, however, declined to recognise the disease as plague. Under the circumstances it has been found difficult to obtain any statement of the number of the October cases and deaths; but it is said that from November, 1901, to February 20th, 1902, 40 cases of plague were recorded, 10 of them fatal. It is probable that the infection in this instance was brought from Rio de Janeiro where plague cases were about the time becoming numerous.

Macahé.—A few cases of plague occurred in February, 1901, at the town of Macahé, in the province of Rio de Janeiro, the infection having been brought from Rio. Details of the outbreak have not been obtainable.

The Argentine.

San Nicholas is a town situated on the River Parana. Plague broke out here in December, 1900, and up to March, 1901, some 18 cases and 8 deaths had been reported. Fifteen of the above attacks occurred in men engaged in grain warehouses. This outbreak was not officially reported. It is stated that previous to the appearance of these cases dead rats had been found lying about in and near the grain warehouses. In dealing with the threatened danger of spread of the infection some 400 labourers were injected with anti-plague serum.

Province of Cordova.—During February, 1901, a number of suspected plague cases were reported in the towns of Belleville and Manos Juarez, in the province of Cordova.

Buenos Ayres.—In October, 1901, a suspected plague case occurred on board a steamer the *Paraquay*, from Asunçion, in the person of a passenger from that city. On arrival at Buenos Ayres the patient was removed to the isolation hospital where he died. Plague cases had been reported in Asunçion about this time. The vessel underwent the usual disinfection and quarantine, and so far as is known no spread of the disease took place.

No information has come to hand to show that plague occurred in 1901 at Rosario or Tucuman where plague had been epidemic during 1900.

URUGUAY.

Montevideo.—Under date February 6th, 1901, a statement appeared in a Belgian sanitary periodical that some cases of suspected plague had appeared at Montevideo, the capital of Uruguay. No official confirmation or contradiction of this report has been published. It was further affirmed by the periodical referred to that the cases in question had occurred among the men employed in the Customs warehouses, and that in consequence these had been closed and thoroughly disinfected from top to bottom.

PARAGUAY.

Asunçion.—Early in 1901 rumours were afloat that suspicious illness likely to be plague had been observed, but these reports were officially contradicted. In June, however, an undoubted case of plague occurred in Asunçion, and in the autumn other suspected plague cases were reported, some of them being bacteriologically confirmed, but none of them proved fatal, so far at least as is known. The information obtainable is very small, and it is possible that in Asunçion fatal plague cases were certified under other names.

GREAT BRITAIN.

ENGLAND AND WALES.

During 1901 plague appeared in man, mainly on shipboard at the ports of Hull, Cardiff, Liverpool, and Southampton, and in rats on board a ship at Bristol. In a separate memorandum on "plague and suspected plague cases in England and Wales during 1901," at page 329, some details are given as to each of these occurrences; but a short synopsis is for convenience inserted here.

Hull.—Nine cases, eight fatal, occurred in January in connection with the s.s. *Friary*, from Alexandria. (For details of this outbreak, *see* page 332.)

Cardiff.—A single case of human plague, the diagnosis confirmed by bacterioscopic investigation, occurred at Cardiff late in

January, also another case in which the diagnosis was doubtful and in which bacteriological examination failed to yield evidence of plague. There was also an undoubted epidemic of plague among the dock rats and rats infesting certain flour mills. But beyond the instance referred to above there was no extension of the disease from rat to man. (For details, *see* page 338.)

Liverpool.—During September and October a group of 11 cases of what is believed to have been human plague occurred in Liverpool, the precise origin of which was not traced. No illness among rats was discovered before, after, or during the outbreak, although carefully sought for. (*See* page 339.)

Southampton.—A single plague case, in a lascar belonging to the hospital ship *Simla* from Cape Town, occurred at Southampton in March. The case was an obscure one, and was only discovered through the alertness of the then Port Medical Officer of Health, Dr. A. W. Harris. No extension took place. (*See* page 333.)

Bristol.—On board the s.s. *Rembrandt*, from Smyrna, a number of dead rats were found in January during the process of unloading. The disease from which they had died was proved bacterioscopically to be plague. No extension of the infection, however, took place to man or to shore rats, every precaution being taken under the direction of Dr. Davies, the Port Medical Officer of Health. (*See* page 336.)

SCOTLAND.

Glasgow.—After the 1900 plague outbreak, which comprised only 36 cases and 16 deaths, and which lasted from the beginning of August to the end of September, no more was heard of the disease in Glasgow during the remainder of the year, nor during the first seven months of 1901. But between the middle of August and the middle of September, 1901, a small group of cases came under observation. The first of these was a man, B., employed as a carpenter, at No. 3, South Shamrock Street (which it is worthy of mention adjoins Rose Street, where the first recognised plague case occurred in the outbreak of 1899), but who lived chiefly in common lodging houses. He was found on or about August 9th in a dazed condition in the streets, and was taken to the police office under the idea that he was suffering from the effects of drink. He was detained in the cells till next morning, when he was seen by the police surgeon, who found the man's temperature to be 102°. Under these circumstances the magistrate dismissed the charge, and advised the man to seek the advice of the poor law medical officer of the district. He promised, but apparently neglected to do this, for later in the day he was re-arrested in another part of the town, again under suspicion of being drunk and incapable, and was taken to another police station, where he was again detained till morning. As he was obviously ill, medical assistance was sought, and he was ultimately conveyed to the Fever Hospital at Govan, where he died on August 18th. A post-mortem was made, suspicion of plague having arisen, and bacterioscopic investigation was begun.

On August 28th J. T., a boy, was admitted to the Glasgow Fever Hospital, from No. 1, South Shamrock Street, suffering from suspicious symptoms, including fever, delirium, and buboes. His illness had begun on August 22nd. It transpired that this boy's father, J. T. senior, had died somewhat suddenly the previous day (August 27th) after four days' illness, the clinical characters of which were fever, intense headache, slight cough, and bloody expectoration towards the end. This man kept a rag store. As plague was suspected, the family of J. T. were admitted as "contacts" to the Glasgow "Reception House" on August 30th. One of these "contacts," N. T., a daughter of J. T., remained well till the evening of September 10th, when she complained of headache and fever, followed later by a bubo; she was removed to the hospital, where she recovered, as also did her brother whose illness is mentioned above.

On September 11th K. O'B., an attendant at the Reception House, who had had care of the girl N. T. since her admission, who had bathed and superintended the "contacts" admitted on August 30th, and who had taken charge of their clothing, complained of illness, which came to be regarded as plague, of which she died on September 17th.

This group of five cases (three fatal) comprised three members of one family, also a man who had worked almost next door to them, and an attendant who looked after this family in the Reception House. The first case was referred to Govan and the other four to Glasgow.

As has been said, the first case, the man B., worked as a carpenter at No. 3, South Shamrock Street, and the T. family lived and had their rag store at No. 1 of the same street, which is in the area which had been infected by plague in 1900. On August 29th (*i.e.*, after three suspected plague cases had developed in the human subject) a single rat was trapped by some workmen in a cartwright's yard at 202, Rutherglen Road. This yard where the rat was killed is "part of the same congeries of workshops occupying the corner of South Shamrock Street and Rutherglen Road."* The rat which the workmen killed presented to them no evidence of illness, but when it came to be examined by the specialists attached to the Public Health Department of Glasgow there were discovered evidences which pointed to plague, and these were subsequently regarded as being to some extent confirmed bacteriologically. Inoculation experiments showed an organism which grew with "remarkable tenuity, or rather want of vigour." In his report dated September 9th Dr. Chalmers states that rats to the number of over 30 were caught in the same yard and in and about the workshops above referred to, and that two also were found dead; but in none, save the one instance mentioned already, and which was killed on August 29th, was there any evidence or suggestion of plague. Dr. Chalmers added, in respect of the laboratory and

* *See* Reports, by Dr. Chalmers, Medical Officer of Health for Glasgow, on the cases of suspected plague, reproduced in the Annual Report of the Local Government Board for Scotland for 1901, page 58 *et seq.*

other investigations, that "notwithstanding the somewhat contradictory, and in some examples wholly negative, character of several of the experiments, it is impossible, I believe, to escape the conviction that we are dealing with the plague organism. Several incidents suggest attenuation. In artificial culture lack of vigorous growth has characterised all the experiments." Owing to the fact that some of the bacteriological evidence was anomalous, delay took place in the notification of the occurrence of these five cases to the Foreign Office, and through the Foreign Office to the signatories of the Venice Convention. Inquiries instituted by Dr. Chalmers failed to trace how the suspected plague infection had reached the neighbourhood of South Shamrock Street. Some suggestion was made, since the T. family kept a rag store, that infected rags or old clothes might have been the source of the mischief. In this connexion allegation was made that disused khaki clothing of a Scottish militia battalion, which had recently returned from South Africa, had been sold to dealers, some of it being in a filthy condition. But none of this clothing was traced to the store kept by the T. family, nor was there any evidence that the clothing in question had been exposed at any time to the infection of plague. On the other hand, the man B., though working at South Shamrock Street, lived in common lodging houses, where, as is known, infection is often introduced by strangers, whose movements cannot be followed. And since about a fortnight elapsed between this man B.'s attack and recognition of illness in the rag-store keeper, it is not improbable that B. in some way infected the T family. It is also open to surmise that these cases developing among persons working or living in the area in which plague appeared in 1900 fell victims to a recrudescence of the previous infection, the leaven of which had not been entirely destroyed in 1900.

Nothing further was heard suggestive of plague in Glasgow till October 11th, when it was reported that a lascar from the s.s. *Bavaria*, which had arrived at that port from Bombay viâ Marseilles and Liverpool, had been landed and removed to hospital at Govan for observation, suffering from illness which it was thought might prove to be plague. Material from the patient was bacteriologically examined, but with negative results.

As time went on it was assumed that the danger of an outbreak of plague in Glasgow had subsided; but on October 23rd the health authorities were informed of the occurrence of two new cases, and these were ultimately increased by three others, all of the five being connected with the Central Station Hotel. The first case, a young foreigner employed in the hotel manager's office, sickened on October 19th. On the next day, October 20th, a cellarman, whose work was in the basement of the hotel, but whose residence was elsewhere, fell ill; and on the 21st a young woman engaged in one of the lower rooms of the hotel also sickened. From October 21st to October 30th no fresh cases were reported, but on the latter date a servant maid, who assisted in the work of the lower rooms of the hotel, was attacked by illness similar to the others, and next day, October 31st, a barmaid, whose work by day took her to a branch establishment outside Glasgow, but who assisted in the hotel bar in the evenings, and who slept

in the hotel, was also attacked. After this there were no fresh cases, and the group is therefore limited to five, only one of whom, the cellarman, died.

The inquiries made by Dr. Chalmers led him to the conclusion that this hotel outbreak was associated with the occurrence of plague among the rats infesting the basement and lower rooms of the hotel. It seems that the young woman who was attacked on October 21st had complained prior to her illness of bad smells coming from the floor of the room in which she worked, and on two occasions (October 15th and 22nd) two dead rats were found below the flooring. There was a history of a few dead rats having been found in other lower rooms and in the basement of the hotel. On behalf of the Local Government Board of Scotland, Dr. Leslie Mackenzie investigated this hotel outbreak, and he sets out the main facts in tabular fashion as follows in his report dated November 5th, 1901 :—

Name of patient.	Occupation.	Date of sickening.	Date of removal to hospital.	Dead rats found.*
1. J. P.	Clerk	October 19th	October 23rd	1 under floor of office.
2. A. B... ..	Cellarman	October 20th	October 24th	2 in cellar.
3. A. McG. ..	Dessert-room maid	October 21st	October 23rd	5 under dessert-room floor.
4. M. P. ..	Staff maid	October 30th	October 31st	1 or more under the pantry.
5. K. B... ..	Restaurant barmaid	October 31st	November 1st	1 under floor of restaurant.

* The precise date of finding the dead rats is not stated.

Dr. Mackenzie is inclined to believe that rat infection was transferred to the above cases through the agency of fleas from the rats. There appeared to be no evidence in this instance of direct transmission of human infection from case to case.

As to how this outbreak began, and as to its connection, if any, with the previous group of cases which occurred in August and early September, careful investigations were made by Dr. Chalmers, whose report is dated November 4th. He points out that there was no " unusual mortality " or " epidemic intensity " among rats, so often described in connection with plague outbreaks. He thinks it would, however, be reasonable to assume that rats had remained infected by plague in Glasgow since, if not prior to, the previous epidemic in 1900, and that the disease in the rat had acquired its virulence slowly ; and he thinks that " the discovery of two centres of infection in Glasgow within a comparatively short period carries its own meaning."

But it must be remembered that in August, 1901, when the first three cases of suspected plague occurred, there was no evidence at all of rats being infected, hence it might be contended that the rats had derived their infection from man, and not man from the rats.

In any case subsequent events showed that though other premises in the vicinity of the Central Hotel were infested by rats, some of which were ill of plague, no extension of the disease to man took place. For example, in the basement of certain tea-rooms in Gordon-street dead rats were reported to have been found on November 7th, and a rat warren was discovered abutting on the premises. While the rat burrows were being broken up 67 rats were killed or found dead; of these 67 rats 40 (13 picked up dead) were found infected by plague. But the men employed in breaking up the rat warren and the 22 persons employed in the tea-rooms, not to mention the customers, had no illness whatever, so far as is known, suggestive of plague. In an adjoining fruit warehouse three rats dead of plague were found, as also a kitten which had died from plague, with evidence of having been bitten by a rat. But no human cases supervened among the 21 persons employed there. It may be added that altogether 96 rats obtained from the hotel in question were examined, and only 17 were found infected. During the fortnight ended November 2nd 534 rats were killed or found dead in Glasgow, and of that number only 13 had suffered from plague; and for the fortnight ended November 16th some 296 rats were examined, and of these 52 were found infected by plague. All of the latter were found within a short distance of the hotel.

In concluding his report Dr. Chalmers says that, in his opinion, the facts he has gathered fully warrant "the assumption that the dejecta of the rat contribute largely to the spread of infection." To the opinion that the dejecta of rats may contribute in some degree to the spread of plague infection no objection can be offered, as rats are very liable to suffer from the septicæmic form of plague which is frequently attended with hemorrhages from the bowels, and the blood in such cases is known to be swarming with plague bacilli. The touching of such dejecta with the hand or bare foot on which any abrasion is present would be likely to cause inoculation of plague.

It is of interest to summarise the experience of Glasgow in respect of plague. In 1900 a limited outbreak occurred in man, the origin of which was never satisfactorily traced; no infection of rats before the outbreak, or during its course, having been discovered, though carefully sought for. Then, after an interval of nearly a year there occurs a group of five cases, mainly associated with a rag store situated in the area infected in the previous year; and, after three human cases have been notified, a live rat killed by workmen in a yard near the rag store is examined and found to yield evidence suggestive of plague. Two subsequent cases follow in the human subject, secondary apparently to human infection derived from some previous member or members of the group just mentioned. Then, five weeks after the occurrence of the last case of the group of five just referred to, a new group of plague attacks is discovered in a city hotel employing some hundreds of persons in one or another capacity; and this later occurrence is associated, with the infection of a few of the rats infesting the basement of the establishment, where it is stated dead rats were found, but not in any large numbers. Extension of the infection next took place to rats in adjoining houses

where larger numbers of plague infected rats were discovered, but where no human subjects appear to have been attacked. Small numbers of plague infected rats continued to be found in Glasgow from time to time during the rest of 1901, extending into 1902, but without, so far as is known, a single human case of plague supervening beyond the 10 enumerated above.

From this it would seem that the danger of plague to man from the rat infection of a city is by no means so great as some writers would lead us to suppose.

FRANCE.

Marseilles.—Though no cases of inland plague occurred in France during 1901, no fewer than 29 shipborne cases of the disease were officially reported from the port of Marseilles, *i.e.*, in connection with the lazaret at Frioul, during the second half of the year. All the plague cases and deaths which occurred on ship board prior to reaching French ports are apparently not included in these figures. In addition, certain ships were found to be infested with plague stricken rats, though no human cases had occurred on board.

Marseilles is practically the main portal through which passengers and merchandise from the East enter continental Europe. It is stated that altogether 15 ships came under observation at Marseilles as infected with human or rat plague. Among the ships found infected with plague stricken rats were the *Cambodge*, the *Saghalien*, and the *Braila*, from the Levant.

1. Among the ships on which plague occurred in the human subject was the *Laos*, which arrived at Marseilles from Hong Kong and Calcutta having touched at Djibuti in the Red Sea, at which port a number of Arab stokers were taken on board. One of these men was attacked by plague on June 28th, before the vessel reached Suez, and two others succumbed to the disease between Port Said and Marseilles. On arrival on July 7th at the latter port the master reported 15 cases of plague among the stokers; other cases occurred while the *Laos* was at Frioul, the quarantine station for Marseilles. Altogether 23 cases and five deaths were reported in connection with this vessel. None of the 317 passengers of the *Laos* was attacked. On July 11th bacteriological examination of a rat killed by the disinfection, showed the presence of the plague bacillus.

2. Another ship on which plague appeared was the *Senegal*, which left Marseilles with a party of 174 scientific tourists on September 14th for a voyage to the chief ports in the Levant. On September 15th one of the crew was attacked by plague, and examination of some rats caught on the ship showed that they also had contracted plague. The vessel then returned to Marseilles, and on the way back a second member of the crew developed plague. One of the cases proved fatal. The whole of the persons on board the *Senegal* were landed at Frioul to undergo ten days' observation, and considerable discomfort was caused to the 174 tourists by the defective organisation and insufficiency of the

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Summary of the Progress and Diffusion of Bubonic Plague in 1901; by Dr. Bruce Low.

arrangements made for them at this station. No further cases developed. The *Senegal*, 17 days previous to taking the tourists on board, had returned from Alexandria. It has been suggested that plague infected rats came on board the *Senegal* while she was in the Port of Alexandria. But it has also to be remembered that in January, 1901, a case of plague was landed from this vessel at Alexandria, and that the rats on board were then said to have been infected by plague (see under Egypt, page 321).

3. On the *La Ciotat*, from Noumea, a case of plague was reported, at Marseilles on September 30th. No extension of the disease followed on board the ship. A rat found dead on board on October 2nd was found to have died from plague.

4. On the *Szapary*, from Naples, two cases of plague, both of them fatal, occurred on the ship's arrival at Marseilles, the first case on September 30th, and the second on October 2nd. Very few rats were found on board—none infected by plague as far as is known.

5. On the *Equateur*, from Smyrna and other ports in the Levant, one case of suspected plague was reported on October 23rd on arrival at Marseilles to have occurred during the voyage.

6. The *Peninsular*, from Bombay, reached Marseilles on November 17th and landed two cases of illness which the French authorities pronounced to be plague. The ship did not go to Frioul to undergo the ten days' observation, but sailed for London, where she was duly dealt with after the English fashion. No further cases were reported.

7. On December 4th the *Peiho*, from the Levant, landed a soldier sick with plague at the Marseilles lazaret. Though not bacteriologically proved, it was thought that one rat examined gave grounds for suspicion of plague.

8. On December 20th the *Goorkha*, from Calcutta, arrived at Marseilles and reported that one of the crew had died from suspected plague shortly before reaching the port. In this case also the master of the vessel elected to sail direct for London to be dealt with there, in preference to submitting to the prolonged observation required at Frioul. No other cases followed.

9. On board the *Ernest Simons*, from Bombay, there was reported at Marseilles, on September 12th, a case of suspected plague.

In addition to the above, the *Ormuz*, from Sydney, and the *Nérite*, from Pondicherry, are said to have had suspected plague cases on board, but which were not bacteriologically confirmed. The *Portugal*, from Alexandria, was regarded as infected on arrival, as she had landed a case of plague at Alexandria before sailing.

It was stated that the rats at one of the Marseilles docks had become infected by plague. The dock was at once closed and a rat hunt was organised, and much merchandise stored in the wharves was disinfected. No reports have been published showing that any human cases of plague in Marseilles followed the shore rat epidemic.

Havre.—At this port, in 1901, a ship, the s.s. *Ile-de la Réunion*, was found infested by plague stricken rats. The vessel was dealt with as if human plague had been in question. The diagnosis of plague in the rats was bacteriologically confirmed. No further development of plague occurred at Havre in connection with this vessel.

ITALY.

Naples.—In September and October, 1901, an outbreak of plague appeared at Naples, affecting chiefly workmen engaged in the bonded warehouses of the port, and at a mill. Although the recognition of the disease did not take place till September 23rd, it is admitted that a number of cases of unusual illness had been occurring in the locality, cases which had been classed under various designations as adenitis, typhoid fever, typhlitis, pneumonia, and strangulated hernia. It appears that during August there had been observed an unusual mortality among rats in and about the custom-house quays, and later bacterioscopic examination of rats recently dead showed that they had been suffering from plague. The merchandise stored on the quays consisted chiefly of grain, skins, and bales of cotton, brought from foreign ports. The rats found dead during August were swept from the quays into the water, and when plague was declared to be attacking these animals a panic seized the authorities lest the fish caught in the Bay of Naples should become infected by these dead rats; hence a decree was issued suspending all fishermen from fishing in the bay. This decree deprived the fishermen of their means of obtaining their livelihood and caused great suffering among them. Similar measures were used to stop the selling of rags, causing rag dealers great loss and reducing them to an appeal to the Government for relief.

The actual number of plague cases which occurred at Naples is differently stated by different authorities, some giving 26 and others 17 as the total number. It is probable that, as stated above, a number of the earlier cases escaped notice altogether. The certified plague deaths numbered eight.

As to the mode in which the plague infection reached Naples there was conflict of opinion. It was believed that plague infected rats had landed from one or more foreign ships and had conveyed the disease to the rats infesting the warehouses on the quays; two illustrations being quoted: (1) A ship from Levantine ports having on board some bales of cotton, originally coming, it is said, from Bombay, which were landed at Naples. Rats it is alleged might have been concealed in the bales. (2) A ship from Calcutta which had called at Alexandria and brought a cargo of hides in a putrefying condition. Rats it was suggested might have arrived at Naples by this ship, though other persons regarded it as probable that the hides themselves brought the infection. M. Proust, at the Academy of Medicine at Paris, quite recently propounded the theory that the disease was brought to Naples by an English vessel from Cardiff, which vessel had carried a cargo of hides

transhipped at the English port from India. No evidence, however, was adduced in support of this somewhat extraordinary suggestion.

GERMANY.

Hamburg.—On December 23rd, 1901, the "Hamburgische Correspondenz" stated that a dead rat, bacteriologically proved to have died of plague, had been found on board the Levant Liner S.S. *Chios* which had recently arrived at Hamburg. At the time the dead rat was found the cargo had been largely unloaded, and some of it had gone by rail into the interior. The vessel was at once isolated and disinfected, and the crew and persons who had been at work upon her were kept under observation by the port medical officer. No illness of a kind suggesting plague had occurred on the vessel, and no suspicious sickness was subsequently discovered among the crew or the dock labourers. Inquiries made by the police traced part of the cargo consisting of 182 bales of goatskins to Frankfort-on-Main, where they had been delivered at a tannery in the city. Telegraphic instructions were sent from the Central Health Authority that the skins were to be disinfected by a solution of cresyl, but the consignee objected on the ground that this would ruin them, whereupon the Minister of Health wired that formalin might be employed instead of cresyl. But the district medical officer intervened and pointed out that formalin would coagulate the albumen on the skins and spoil them for their intended purpose. Finally, the Minister telegraphed that it would suffice to place the skins at once in the lime pits at the tannery, and this was done. The employés of the tannery and those who had carted the skins from the railway to the works were kept under medical observation for some time, but no illness occurred among them. The railway trucks and carts which had been used in conveyance of the skins were disinfected.

RUSSIA.

Odessa.—During October, 1901, information reached this country that plague had broken out at Odessa. It was not till November 9th that an official notification was issued, in which it was admitted that two cases had occurred, both fatal. The last of the deaths took place on November 8th. Other reports in the local press spoke of three plague deaths, but added that it was found impossible to obtain authentic information from the authorities, who for fear of alarming the people observed a rigorous reticence. Indeed, the public unrest was so great that there appeared to be danger of a stampede of the inhabitants from Odessa to the inland towns to escape the dreaded infection. This panic, however, soon subsided, and after November 8th no fresh cases were reported.

The first of the two cases was a German resident employed as a cook at one of the harbour restaurants. His illness at first was not recognised as plague, but a bacterioscopic examination proved

the true nature of the malady. The second case, also a male cook, was employed at a sailors' eating house near the docks. He had been ill five or six days before his case came under observation; he was then removed to the hospital, but died within two hours of his removal. The diagnosis in this case was also bacteriologically confirmed. These two men were friends and had been in contact. Several other cases of a suspicious nature were reported, but were not bacteriologically confirmed.

As to how plague reached Odessa no definite information has been forthcoming. Some persons traced the infection to an Austrian steamer which had arrived some little time before at Odessa from Smyrna, having on board the body of a man who had died a few hours before the vessel came into port. Though not recognised at the time, it is suggested that this man's death had been due to plague, but there is no confirmation of this. Others were of opinion that plague had been brought from Batoum, where plague cases had been noted about the same time as at Odessa. Some alarm was caused towards the middle of November by the finding of a number of dead rats in the sewers of the town. Odessa, as is known, is a great shipping port for grain, and the warehouses where this is stored are infested by rats.

When plague was first officially recognised the infected house was surrounded by a "cordon" and the inmates placed under medical surveillance. A temporary plague hospital was extemporised with six large closed-in railway luggage vans in an isolated position near the harbour, and a locomotive was attached so that in the event of a plague patient dying in any of the vans it could be uncoupled and run to another isolated place and fired. Medical inspection of all eating houses, lodging houses, and public conveniences was at once instituted. A plague committee was formed and met daily. The provisions of a Russian law were put in force, whereby any person spreading false reports or inventing wild stories regarding plague could be summarily fined 500 roubles or sent to prison for three months. No further cases, as has been said, were reported after November 9th, 1901, but in the summer of 1902 there was a fresh outbreak of the disease. It is also of interest to mention that during the early part of 1902 "spotted typhus fever" was reported as prevalent in Odessa.

Nicolaiev, a port in the Black Sea, with a population of about 70,000, came under suspicion during November, 1901, of being infected by plague, owing to occurrence of suspected illness in a prisoner who had been brought from Odessa and who died on November 7th. A special investigation of the case was made, including bacteriological examination, with the result that the diagnosis of plague was not confirmed, death being ascribed to blood poisoning from a "phlegmon" on the arm.

Batoum.—On October 14th a resident died with symptoms suspiciously resembling plague, and a second case quickly followed. A bacteriological investigation with material taken from the second case confirmed the diagnosis of plague. In December a third case occurred in the person of an old woman. In January, 1902, another case was removed to hospital with suspected plague, where death took place next day.

It is believed that Batoum received its infection from the Turkish port of Samsoun with which it has trade connections.

Kutais, a port in the Black Sea, with a population of about 13,000, was reported to be infected by plague during the first few days of January, 1902.

Kamischin District.—In the village of Kotowo, in the district of Kamischin, in the Government of Saratoff, situated near the River Volga, about 400 miles from its mouth, plague was reported to have broken out towards the end of 1901. Twelve persons had been attacked up to January 5th, 1902, and of these nine had died. The disease was known locally as the "Siberian plague."

TURKEY.

During 1901 plague appeared in a considerable number of localities within the Ottoman Empire, including Constantinople, Samsoun, Smyrna, Chios, Beyrout, Yambo, Djeddah, Assyr, Bassorah, and Bagdad.

1. *Constantinople and environs.*—On January 8th, 1901, a Bosphorus boatman died from plague, the diagnosis being bacterioscopically confirmed. This illness was regarded at first as "influenza," then as "typhoid fever," and lastly, after death, as plague. The next case was not observed till the end of April, the patient being employed in a macaroni factory; three more cases were reported in June; subsequently small groups of cases came under notice, the total cases during 1901 numbering 28, of which eight proved fatal. It is stated on the authority of the United States Sanitary Commissioner at Constantinople that some cases of fever with glandular enlargement had been medically attended in the early part of 1901, but that the disease had not been recognised as plague at the time. The type of the malady was mild, and this perhaps enabled it to escape recognition at first. The cases were distributed over a somewhat wide area, including places north and south of the Golden Horn, Galata, Cassim Pacha, Pera, Beshiktash, Scutari, Sari Yeri on the Upper Bosphorus, 15 miles from Constantinople, as well as on the Asiatic shores of the Sea of Marmora, 20 miles from the city.

On October 17th a sailor suffering from plague was landed at Constantinople, and taken to the French hospital without the knowledge of the port authorities, from the Messageries Maritimes s.s. *Equateur*, which left Smyrna on October 15th and Beyrout on October 11th. This ship had left Marseilles on September 18th, touching at Naples on September 21st (plague was present in Naples about that time), Constantinople on September 26th, thence to Beyrout and Smyrna, and thence back to Constantinople. It is noteworthy that in September, 1899, the *Equateur* landed a plague case, which was ultimately fatal, at the Beyrout lazaretto.

2. *Samsoun*, on the coast of Asia Minor in the Black Sea, has a population of about 35,000. In September plague was reported to have appeared in this town, the first person attacked being a

grain dealer. Altogether there were 11 recognised plague cases, only one of which proved fatal. There is a statement that dead rats were found about a month before the outbreak in some grain stores in or near which some of the persons worked who were subsequently attacked by plague. The bacteriological examination of some of the rats showed that they had died of plague. How Samsoun was infected is not precisely known, but there were strong suspicions that the disease was brought from Constantinople.

3. *Smyrna.*—Some cases of plague occurred in Smyrna during 1900. In January, 1901, a single case came under notice, and in February another fatal case was reported. In May a suspected case was found on board an Italian steamer on its arrival at Smyrna from Constantinople. In September an Italian working on the Smyrna Aidin Railway was attacked by plague, the diagnosis being bacteriologically confirmed. And in December a waiter in a restaurant on the Smyrna quays was certified to have plague, bacterioscopic proof of the presence of plague bacilli in material taken from the patient having been furnished; and in January, 1902, another waiter in a café on the quay was similarly attacked. The occurrence of these sporadic cases of plague leads to the conclusion that probably they were members of a series, the intervening links of which had not been discovered, the type of the disease being mild.

The village of *Thomaso*, near Cordelio, was infected at the end of December, 1900, the cases extending into January, 1901. A man sickening from plague travelled from Smyrna to Thomaso to his brother's house, where he died. From this case some 12 others were infected, nine at Thomaso and three at the adjoining hamlet of Papa Scala. Personal infection seems to have played a prominent part in this outbreak, those attacked being relatives who had nursed or visited the earlier cases.

Chios.—Two fatal cases of plague were reported in July, 1901, in the island of Chios.

Beyrout.—Although no actual cases of plague were notified during 1901, there existed in the minds of some persons a suspicion that plague, which had occurred there in 1900, still lingered on in a mild form in Beyrout. Early in January, 1902, plague was again reported to have re-appeared at this port.

ARABIA.

The Hedjaz.—Fortunately plague did not attack the Hedjaz itself during 1901. Djeddah, which had suffered from plague in 1896, 1897, 1898, 1899, and 1900, escaped in 1901; and the port of Yambo, which had been attacked in 1900, also was free from plague during 1901.

Assyr.—In April, 1901, plague was reported from the village of Cassim Sabil, in the district of Den Sheïr, in the Sandjak of Assyr in the Vilayet of Yemen, and in some adjoining villages. According to an official bulletin 73 cases and 26 deaths had been

reported up to the end of July. Assyr is regarded as one of the areas in which plague is endemic, outbreaks of the disease having been recorded from time to time since 1815. In recent years plague has been reported as epidemic in Assyr in 1890, 1893, 1894, 1895, 1896, 1898, 1899, 1900, as well as in 1901; but the accounts which reach Europe as to these outbreaks are meagre. The danger of the spread of plague from Assyr, as has been mentioned in previous reports, is increased by the fact that many caravans from Southern and Western Arabia pass through Assyr on their way to and from the Hedjaz, and hence infection may be carried to other pilgrims on the way to Mecca, or may be brought back with the returning caravans.

Aden.—On December 5th, 1901, a single fatal plague case in a lascar sailor, on board the *Patiala*, was reported at Aden, the patient having been attacked on the voyage between Bombay and that port. There was no extension of the disease, which it may be remembered had been epidemic in Aden from February to June, 1900.

Mesopotamia.

Bassorah.—(Population about 10,000). From the end of April to the end of May, 1901, 11 plague cases, nine fatal, were reported at Bassorah (or Basra). The insanitary condition of this town is proverbial. The natives are said to use the canal as their washing place for clothes; they bathe in it; they use it as a receptacle for house refuse, and as a cesspool wherein to discharge all excreta and slop water; at the same time they draw their drinking water from this source.

Bagdad.—In May, 1901, some plague cases occurred in the Sadrieh quarter of Bagdad City. The first case was a Kurdish woman, the wife of a dealer in old clothes, and it was surmised that infected clothes from India, or perhaps from Bassorah, had introduced the disease into Bagdad. Definite information as to the occurrence of subsequent cases was withheld; but it is established on medical evidence that some six cases of undoubted plague did occur, although the mouhtars, imams, and other officials denied the presence of the disease. Later in the year a number of persons suffered from fever with enlargement of the glands, some 10 cases being referred to the Jewish quarter of the town. The type of the disease was mild, and it was therefore the more easily concealed. By some the malady was regarded as malarial fever with enlarged glands.

The Turkish authorities established two temporary hospitals to receive cases. Cavalry patrols were sent out to watch the country, and to see that travellers were detained in quarantine for five days, their effects being disinfected and exposed to the rays of the sun. Government medical officers and army surgeons were sent into the neighbouring villages to supervise the health and sanitary arrangements of the people. Plague reappeared in Bagdad in January, 1902, ten cases and seven deaths from the disease being reported during that month.

PERSIA.

Seistan.--About the middle of the year 1901 a report appeared in the public press that a caravan of pilgrims from Sindh to Mesched had been attacked by plague, and that out of 169 persons comprised in caravan 78 had perished from the disease. In support of the allegation that the epidemic malady in question was bubonic plague it was mentioned that those who had been attacked suffered from suppurating swellings in various regions of the body. To prevent the spread of the epidemic the Persian authorities forbade the remainder of the caravan to continue their pilgrimage and forced them to return to India. All the clothing and effects of those who were attacked were burned. No further news of plague in Persia during 1901 has come to hand.

EGYPT.

The total number of plague cases throughout Egypt during 1901 numbered 206, and of these 104 or 50·7 per cent. proved fatal. These cases were distributed over nine different localities.

1. *Alexandria* (estimated population, 319,776), it may be remembered, was invaded by plague in 1899, when 93 cases (45 fatal) were reported; in 1900 plague reappeared, but only 35 cases (20 fatal) were notified. In 1901 plague once more appeared, and for the third year in succession, 52 cases (26 fatal) being recorded. While the persistent recurrence of plague in Alexandria year after year gives rise to suspicion that the disease has again established itself in Egypt and may at any time assume grave epidemic proportions, still, the comparative smallness of the number of reported cases affords grounds for anticipating that, in some respects at least, the active measures employed by the Egyptian sanitary administration to combat the spread of the disease have checked its extension and will keep it at bay.

The first recognised plague case in 1901 in Alexandria came under observation on April 7th, when a native was found dead in the Gabbari quarter, a western suburb of Alexandria. There was a bubo in the dead man's groin and bacterioscopic examination proved that death had been due to plague. He had worked occasionally in the market gardens situated near the quarantine station. These gardens are manured with ordure coming from the populous parts of Alexandria. It is a custom with those who work in these gardens to collect rags and other articles found among the ordure. In the absence of any other source of infection, it has been suggested that plague infected rags, might have been handled by this man and conveyed plague to him.

The next cases, three in number, occurred in May, two of them being discovered after death. In June, three cases; in July, seven; in August, eight; in September, 19; in October, seven; and in November, four cases were reported.

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On November 19th the last case of the year terminated. But in February, 1902, the disease again manifested itself, some 27 cases (14 fatal) being notified up to June 30th.

The subjoined table shows the number of cases and deaths month by month during 1901:—

—	1901.									Total in 1901.
	April.	May.	June.	July.	August.	September.	October.	November.	December.	
Plague cases	1	3	3	7	8	19	7	4	—	52
Plague deaths	1	3	1	2	4	10	3	2	—	26

2. *Port Said* (estimated population, 42,000), which had been invaded by plague during 1900, 89 cases and 35 deaths having been reported, suffered again in 1901, when 26 cases (16 fatal) came under observation. These cases were scattered over a period of about four months, June to September inclusive. During August a considerable number of dead rats were found in the native quarters of the town. Some of these rats are stated to have had glandular swellings.

3. *Zagazig* (estimated population about 40,000), a town in the Eastern Sharkieh Province of Lower Egypt, about 60 miles by rail north of Cairo, and the centre of a flourishing agricultural district, was invaded by plague at the beginning of June, 1901. About the middle of May it is stated that an excessive mortality among rats was observed. The first two plague cases were women, one a Greek and the other a Jewess. It is believed that the infection in all probability was introduced from Alexandria or from Port Said. The current opinion was that the disease was conveyed by means of infected grocery stores, the persons earliest attacked being associated with grocers or their assistants. It is suggested locally that rice and flour from the bonded warehouses in Alexandria (where dead rats had previously been found) were the infective articles. Some persons laid blame upon imported quantities of soap packed in loose netting from Beyrout, where, also, cases of plague had previously occurred. From June 1st to the end of August, 77 plague cases (32 of which proved fatal) came under notice in Zagazig.

4. *Mansourah* (estimated population, 37,000).—This town is situated in the Nile Delta about 60 miles north of Zagazig. On June 6th a single fatal case of plague occurred in the person of a man who had travelled from Zagazig. No other cases followed.

5. *Minieh* (estimated population about 20,000) is a town on the west bank of the Nile, in Upper Egypt, 300 miles from Alexandria and 150 miles south of Cairo. Early in June plague appeared; but the outbreak was limited to five cases only, one of which

proved fatal, all of them being reported during the same month (June).

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6. *Mit-Gamhr* (estimated population, 14,000), a town situated on the east bank of the Damietta branch of the Nile, was invaded by plague in August, 1901. The first observed case was that of a young Greek who had been employed at a Greek bakery where rice and flour from Alexandria were being used. The local theory was that the infection had reached Mit-Gamhr from Alexandria by means of this merchandise. The total number of cases observed amounted to 20 (11 fatal), and these were distributed over the four months, August to November inclusive. During this small outbreak at Mit-Gamhr dead rats were found in infected houses, and bacterioscopic examination showed that they had died from plague.

7. *Benha*, a town of about 10,000 inhabitants, situated about 40 miles north of Cairo and in the Province of Galioubieh, was invaded by plague in September, 1901. This town is connected by a light railway with Mit-Gamhr, whence the infection in all probability came. There were reported altogether only five cases with three deaths. During the disinfection of the house in which the first of the recognised cases occurred several dead rats were found, and on examination some of them appeared to have died from plague.

8. *Ziftah*, a town of about 14,000 population, situated on the west bank of the Damietta branch of the Nile, exactly opposite Mit-Gamhr, became infected by plague in October, 1901. Probably the infection came from Mit-Gamhr, there being constant communication between the two towns. Altogether 10 cases, eight fatal, were recognised from October to December inclusive. In the early part of 1902 a few more cases occurred in Ziftah and in some neighbouring villages.

9. *Tantah*, the capital of the Province of Sharkieh, is one of the largest and most crowded towns of the Delta. It has a population estimated at over 60,000. Plague appeared here in December, 1901, and during that month 10 cases with seven deaths were reported. This proved the beginning of an epidemic which continued during the earlier part of 1902, nearly 100 cases being notified up to the end of April. In Tantah attempts were made to conceal cases, and a considerable proportion of the reported instances only came under notice on being discovered dead at their homes.

In an official report on plague in Egypt during 1901, Pinching Bey, Director-General of the Egyptian Sanitary Department, states that "In all the towns infected there have been invariably an intimate connection between the disease among rats and human beings, but our experience has not altered the opinion expressed in my report of 1900 that rats* spread infection and cause isolated cases of plague among the human race; but the true epidemic

* During 1901 the number of rats destroyed by the officials of the Egyptian Sanitary Department amounted to over 12,000.

ship had come from Marseilles, Beyrout, and Port Said. No among human beings is caused by human beings, and the highly dangerous cases among them are the pneumonic cases."

In reviewing the incidence of plague in Egypt during the three years 1899–1900 and 1901, it is evident that the disease has established itself somewhat firmly in the country, and in the future is not unlikely to afford more evidence of its presence.

In addition to the cases of plague occurring in Egypt on shore, there were reported some cases of plague and suspected plague on board ships arriving from various countries at the ports of Alexandria, Port Said, and Suez.

On January 10th, 1901, the Messageries Maritimes s.s. *Senegal* arrived at Alexandria having on board a steward's assistant suffering from fever and buboes; he had been taken ill while the vessel was at Beyrout on January 6th. The patient would have been landed at Beyrout, but the authorities there refused to take him at the lazaretto. The vessel was disinfected after the patient had been landed at Alexandria, and no further spread occurred at the time. It is, however, interesting to note that an outbreak of plague took place on board this same ship in mid-September, 1901, two days after she left Marseilles with a party of 174 scientific tourists for a trip to the East. The rats on board were found infected by plague on this last occasion, and it is stated that rats were found on board believed to be infected by plague at the time of the occurrence of the single human case in January at Alexandria.

No further ship-borne cases were reported till September 26th, when the Austrian Lloyd s.s. *Maria Theresa* arrived at Alexandria from Port Said, Smyrna, and Constantinople. On medical inspection three persons were found suffering from fever and buboes. Bacterioscopic examination definitely proved that two of the cases were plague. All three recovered.

On October 22nd the P. and O. s.s. *Arabia* arrived at Port Said from Marseilles having a suspected plague case on board. The case was landed but was definitely proved not to be of the nature of plague.

On November 2nd, 1900, the English s.s. *Glengyle*, from Shanghai, Amoy, Hong Kong, and Singapore, arrived at Suez, where a Chinese member of the crew was found to be suffering from a suppurating bubo, and an English mercantile marine officer was also ill with fever and a bubo. The diagnosis of plague was not confirmed, but the ship was disinfected, and no further cause of a suspicious nature followed.

On November 5th the Austrian s.s. *Jupiter* arrived at Alexandria from Levantine ports, having on board a steward's assistant suffering from fever and a bubo. A bacterioscopic examination of material taken from the patient's bubo was made, but with negative results as regards plague.

The Messageries Maritimes s.s. *Portugal* arrived at Alexandria on December 4th, having on board a case considered as plague, a diagnosis which was later on bacteriologically confirmed. The

extension of the infection took place. A suspected case of plague the diagnosis of which was not confirmed occurred on this ship on its previous voyage to the Levant, in the month of October.

On November 28th the s.s. *Marienfels* arrived at Suez from Calcutta, and on the crew being medically inspected a lascar was found suffering from a bubo which had been first noticed on November 5th. There was no apparent cause for the bubo. The patient was landed at the Moses Wells lazaretto, and the ship was disinfected and passed through the canal "in quarantine."

AFRICA.

Cape Colony.

The Cape Peninsula.—Early in 1901 Dr. Gregory, the Acting Medical Officer of Health for Cape Colony, found that rats at the Cape Town docks were dying from a fatal form of epidemic disease, which later on was proved to be plague; and during the first week of February several coloured labourers who had been working at the docks were certified to be suffering from bubonic plague. It is stated, however, that cases of a similar sort had been occurring in Cape Town since November, 1900. It has to be remembered that an outbreak of plague was reported in November, 1900, near King William's Town, in the Colony, and that early in the year, 1900, plague had been brought to Cape Town from Rosario in a forage ship, in connection with which six cases occurred. No sick persons had been landed at Cape Town docks, the ship having been sent to the quarantine station, a considerable distance away, along the coast, and involving a journey of several hours by steamer. Whether there had been a succession of unrecognised human cases between the imported cases and those of later date is not known. Some persons believe that the local rats had been long infected, and that the disease had been maintained in Cape Town by them till it acquired sufficient virulence to be recognised in man. Be that as it may, the disease spread in the Cape Peninsula after its recognition in February, 1901. The outbreak reached its height in March and April, and gradually subsided in May and June; after that period only sporadic cases were reported. The last plague case reported in the Cape Peninsula was on October 21st, and from that date to January 2nd, 1902, no fresh cases came under notice, though plague infected rats were found from time to time. Up to January 2nd, 1902, 745 cases and 362 deaths from plague were recorded in the Cape Peninsula (which includes Cape Town and several adjacent municipalities), a case mortality of 48·5 per cent. Of the 745 attacks 192 were Europeans, 408 were "coloured," and 145 were natives. The case mortality among "coloured" persons was 57·1, among natives 42·8, while among Europeans it was 34·9. Among the European fatal cases was that of one of the medical officers at the Cape Town Plague Hospital. His infection was received from a wound while making a post-mortem examination. Two white nurse employed at the plague hospital (one of them acting as matron) contracted the disease and died from the pneumonic form of the malady.

Port Elizabeth.—About the middle of April, 1901, plague was reported to have invaded Port Elizabeth, a native being discovered ill of the disease on April 16th. Four days before the first human case was recognised dead rats had been found in proximity to stores of grain collected for military purposes. The man first attacked by plague worked in the locality where the grain was accumulated, though he lived in a native location, outside the town, about two miles off. From this it was surmised that the first human case had derived his infection from the plague stricken rats, though on the other hand some persons contended that it was equally possible that the rats got their infection from some human case. In any event it is probable that the plague infection at Port Elizabeth was imported in one way or another from Cape Town, or perhaps from South America by forage ships. The disease did not spread quickly, and for some time only scattered cases were reported. Up to the end of 1901 there were certified 104 plague attacks, of which 50 proved fatal, a case mortality of 48·1. Of the 104 persons attacked 19 were Europeans, including two medical men employed in plague duty, both of whom contracted the disease while engaged, one after the other, in pathological work at the lazaretto and in the town; 29 were "coloured," and 56 were natives. The case mortality among the "coloured" was 55·2, among the natives 50, and among the Europeans 31·6.

Mossel Bay.—In December plague was reported at Mossel Bay, which lies on the coast about midway between Cape Town and Port Elizabeth. Up to the end of the year nine cases were notified, and of these three proved fatal, a case mortality of 33·3 per cent. Of the nine attacks three were Europeans, none of whom died, while six were "coloured," of whom three died, a case mortality of 50 per cent. It is said that about the middle of October dead rats infected by plague had been discovered at the Bonding Warehouse at Mossel Bay.

In addition to the outbreaks of plague in the Cape Peninsula, Port Elizabeth, and Mossel Bay just mentioned, there occurred 13 other cases, five fatal, in a number of different localities throughout Cape Colony, viz.:—Hermon, one case; Imvani, one case; Mafeking, two cases; Somerset West, four cases; Somerset West Strand, one case; Stellenbosch, one case; Uitenhage, one case; and Ladismith,* two cases.

The total notified plague cases in South Africa in 1901 amounted to 871, of which 420 proved fatal, a case mortality of 48·2.

It may be added that at East London plague infected rats were found in April, 1901, but no human cases were reported during the year.

Mozambique.

Magude.—Plague broke out at Magude, which lies some 40 miles north of Delagoa, in 1899 and subsided in January, 1900, No further cases of the disease came under observation till November, 1901. No detailed reports of this outbreak have been published, and the evidence from different sources is somewhat

* Not Ladysmith, which is in Natal, and with which place Ladismith is often confounded.

conflicting. But it was officially announced on January 17th, 1902, that Mozambique was now free from plague.

Beira.—In December, 1901, the s.s. *Clan Ross*, with a cargo of railway material from a Cape port, arrived at Beira. A case of plague had occurred on board during the voyage, and the ship was in consequence "placed in quarantine" by the Portuguese authorities. No extension of the disease took place.

RÉUNION.

Plague occurred at St. Pierre, in Réunion, during the latter months of 1900, and cases continued to appear during the earlier part of 1901. From November, 1900, to March, 1901, 69 cases with 48 deaths were reported, the last case being notified on March 26th. The course of the epidemic is shown in tabular form below :—

—	1900.		1901.			Total.
	November.	December.	January.	February.	March.	
Plague attacks	2	29	28	8	2	69
Plague deaths	2	17	21	6	2	48

MAURITIUS.

It will be remembered that plague has been prevalent in Mauritius since early in 1899. During the two years 1899 and 1900 some 2,252 cases and 1,649 deaths were recorded. In January, 1901, the disease was still epidemic, but in the spring months and early summer, though plague did not entirely disappear, the number of cases reported became comparatively trifling. About September the usual seasonal recrudescence of plague in Mauritius took place, and at the end of the year the epidemic was still in progress. The subjoined table shows the number of plague attacks and deaths which came under observation month by month in Mauritius during 1901. This table has been compiled from the weekly telegraphed summaries sent by the Governor to the Colonial Office :—

—	1901.												Total in 1901.
	January.	February.	March.	April.	May.	June	July.	August	September.	October.	November.	December.	
Plague attacks ..	121	58	13	3	4	5	4	7	77	324	296	178	1,090
Plague deaths ..	85	50	11	3	2	4	4	4	57	203	182	106	711

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The case mortality was 65·2 per cent., the corresponding rates for 1899 and 1900 having been respectively 73·1 and 72·1.

The majority of the plague attacks occurred in Port Louis, the principal town and port in the island.

The following is a summary of plague attacks and deaths officially reported in Mauritius during the three years 1899, 1900, and 1901 :—

Year.	Cases.	Deaths.	Case mortality per cent.
1899	1,456	1,075	73·1
1900	796	574	72·1
1901	1,090	711	65·2
Total for three years	3,342	2,360	70·6

In each of the three years there has been a recrudescence of the disease in the autumn months, reaching its height in October and November, with a period of comparative freedom in the spring and early summer. It is stated that on the average March is the wettest month of the year in Mauritius, and September the driest. The hottest season in Mauritius is between December and April, the remainder of the year being comparatively cool.

No. 19.

PLAGUE and SUSPECTED PLAGUE in ENGLAND and WALES during 1901; by Dr. R. BRUCE LOW.

App. A, No. 19

Plague and suspected plague in England and Wales during 1901; by Dr. Bruce Low.

(A) *Shipborne Plague and Suspected Plague.*

During 1901, thirty-three ships were reported to the Board as under suspicion of being infected by plague on arrival in English or Welsh ports, but as regards two of them only, the *Friary* at Hull and the *Simla* at Southampton, was actual plague found on board. The details of these two vessels are given further on. In another instance, the *Highland Prince*, from South American ports, was reported on arrival in the Tyne to have had eight cases of what appears to have been true plague, five of them fatal, while on her voyage out from Antwerp and London to the River Plate and back. But no cases had occurred on board for some weeks prior to the vessel reaching the Tyne, and no evidence of existing infection in man or rats on board was discovered after careful examination while she lay in port. In three other instances a vessel reported that she had landed cases believed to be plague at ports on the homeward voyage, viz.: (1) the *Socotra* from Yokohama landed a case at Foochow some seven weeks before her arrival in the Thames. (2) The *Peninsular* landed at Marseilles on her voyage home from Bombay two cases which were stated upon bacteriological evidence obtained at Marseilles to have been true plague. (3) The *Goorkha* buried at sea between Naples and Marseilles a man whose clinical history made it almost beyond doubt that he had died from plague, though no bacterioscopic evidence was obtainable in confirmation of the diagnosis. In addition two other vessels, the *City of Bombay* and the *Clan Robertson*, landed respectively two cases and one case of suspected plague at Moses Wells on the homeward voyage from Calcutta; but in these bacteriological investigation failed to support the diagnosis, the cases, therefore, presumably were not plague. In the case of three other vessels rats on board were reported to be infected; but as regards only one of the three, the *Rembrandt*, at Bristol, was the rat disease proved to be plague. Fortunately no spread of the disease to shore rats took place in connection with the *Rembrandt*, nor was any evidence of transfer of plague from rat to man found after due investigation.

In the appended table are given certain particulars as to the 33 ships which formed the subject of special investigation in regard of alleged importation of plague infection.

It is remarkable, considering the many opportunities which are afforded for the importation of plague into the ports of England

Table showing the **Vessels** which came under **Suspicion** as to **Plague** during 1901, date of arrival in Port, the Ports of arrival and departure, and result of the Special Investigation.

Number.	Name of Ship.	Date of Arrival.	Port of Arrival.	Port of Departure.	Number of Reported Cases under Suspicion.	Result of Bacterioscopic Examination of Material from the Case.	Remarks.
		1901.					
1	S.S. *Persia*	January 4 ..	Thames	Bombay	1	Negative	
2	S.S. *Mars*	" 6 ..	Newport (Mon.)	"	1	"	
3	S.S. *Friary*	" 10 ..	Hull	Alexandria ..	9	Positive	Except the first case, all the others occurred while the ship was in port: eight fatal.
4	S.S. *Highland Prince*	" 11 ..	Tyne	Rosario	—	None	No cases on arrival, but eight cases and five deaths from what appears to have been plague occurred between the ship's departure from England on September 1st, 1900, and her return to the Tyne in January, 1901.
5	S.S. *Rembrandt* ..	" 20 ..	Bristol	Smyrna	Rats only	Positive	
6	S.S. *Scotia*	February 2 ..	Thames	Calcutta	1	Negative	
7	S.S. *Egypt*	" 15 ..	Plymouth ..	Bombay	1	None	The suspected case occurred on the ship while in port at Bombay.
8	Barque *Clara*.. ..	March 4 ..	Newport (Mon.)	Oporto	1	Negative	
9	S.S. *Simla*	" 13 ..	Southampton ..	Cape Town ..	1	Positive	
10	S.S. *Norman*	" 23 ..	" ..	" ..	1	Negative	
11	S.S. *Historian*	April 2 ..	Thames	Calcutta	1	"	
12	S.S. *Thorndale* ..	" 9 ..	" ..	Bombay	1	"	
13	S.S. *Valetta*	May 4 ..	" ..	Calcutta	1	"	
14	S.S. *Canada*	" 5 ..	Southampton ..	Cape Town ..	1	"	
15	S.S. *Caledonia*	" 24 ..	Thames	Bombay	1	"	

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16	S.S. *Malta*	June 17 ..	Thames	Calcutta	1	"	
17	S.S. *Arabia*	" 22 ..	" ..	Bombay	1	"	
18	S.S. *Caduceus*	July	Gloucester ..	Alexandria ..	Rats	"	
19	S.S. *Ormuz*	" 22 ..	Plymouth ..	Sydney	2	"	
20	S.S. *Socotra*	August 5 ..	Thames	Yokohama ..	1	None	The suspected case was taken ashore at Foochow
21	S.S. *Algeria*	" 20 ..	Southampton ..	Beira	1	Negative	Suspected case; landed on June 12th at Foochow Hospital.
22	S.S. *Aston Hall* ..	" 26 ..	Liverpool ..	Bombay	1	"	
23	S.S. *Glenesk*	September 5 ..	Thames	Hong Kong ..	1	"	
24	S.S. *Royal Prince* ..	" 15 ..	Liverpool ..	Alexandria ..	1	"	
25	*Marco Polo*	" 17 ..	Falmouth ..	San Francisco ..	1	"	
26	S.S. *Oakwell*	October 9 ..	Thames	Antwerp	1	"	
27	S.S. *Botha*	" 25 ..	King's Lynn ..	Bona	2	"	
28	S.S. *Cygnet*	November 11 ..	Thames	Naples	Rats	"	
29	S.S. *Peninsular* ..	" 25 ..	" ..	Bombay	2	Positive	These two cases occurred during the voyage, and were landed at Marseilles, where the bacteriological examination was made.
30	S.S. *Plassy*	December 14 ..	Southampton ..	"	1	Negative	
31	S.S. *City of Bombay* ..	" 19 ..	Thames	Calcutta	2	"	These two cases occurred during the voyage, and were landed at Moses Well in the Red Sea.
32	S.S. *Clara Robertson* ..	"	" ..	"	1	"	Ditto ditto
33	S.S. *Goorkha*	" 29 ..	" ..	"	1	None	This suspected case died on the voyage between Naples and Marseilles. Though no bacteriological confirmation was received, the fact that the patient, the clinical character of whose illness, identical with the usual description of plague, had been transferred from another ship on which a case of plague had occurred was held to establish the diagnosis.

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and Wales through vessels arriving day by day from foreign infected ports, that comparatively so few instances of actual plague have been met with. Full details as to the ships *Friary* and *Simla*, as well as of the *Highland Prince*, referred to above, were given in the special plague volume* issued in October, 1902. But brief abstracts of the chief facts in each instance are inserted here.

The S.S. *Friary*, with a cargo of cotton seed, arrived at Hull on January 10th, 1901, from Alexandria. The vessel had touched at Algiers on the homeward voyage. About 12 hours before she reached Hull a sailor died from an attack of illness regarded at the time as influenza. No other sickness was known to exist on board, but on January 12th two sailors became ill and were seen by a private medical practitioner as well as by the port medical officer of health. A diagnosis of "influenza with lung complication" was made. On January 15th two other members of the crew were attacked by similar illness, and subsequently two more cases occurred among the sailors. All of these six patients died, and bacterioscopic investigation showed the death in each instance to have been plague. On January 20th the medical man who had been attending these cases was seized with similar symptoms, as was also a watchman who had been put on board the *Friary* on January 12th and who had visited the forecastle and taken a share in waiting upon two of the men who were ill at that time. This watchman was removed, as was also the doctor, to the isolation hospital, where the former died. Of the nine cases mentioned above, eight died, the only victim of the disease who recovered being the medical man.

All due precautions meanwhile had been taken by Dr. Mason, the Port Medical Officer of Health, as to isolation and disinfection. The ship was moved to the mooring station where she was fumigated by means of sulphur dioxide. The crew's quarters were sprayed with sublimate solution, scraped and then limewashed. The cabins, &c., were repainted. As soon as it became known that the malady on the *Friary* was pneumonic plague the corpses of those who had died from it were cremated. There had been no undue mortality among the rats on board this vessel, though it is admitted that some dead rats were found after she sailed from Alexandria. Before leaving that port a strange cat came on board, and this animal later on became ill and was thrown overboard. A dog on board also was ailing and was killed at Hull; material from it was examined bacterioscopically, but with negative results as to plague. The plague infection was in all probability received at Alexandria, although such infection did not apparently manifest itself in man till the ship was near its destination. The evidence as to rat infection is very meagre, and suspicion points rather to cat infection, though here again the

* Reports and Papers on Bubonic Plague, being an account of the Progress and diffusion of Plague throughout the world, 1898 to 1901, and of the Measures employed in different countries for Repression of the Disease; by Dr. Bruce Low, with an Introduction by the Medical Officer of the Local Government Board.

evidence is incomplete. Notwithstanding that the ship came into dock, and notwithstanding that at first very few precautions were taken, the illness being then regarded as influenza, it is noteworthy that no extension of the disease from the ship to the shore took place, so far as is known, either to rats or to man. The only exception to this was the medical man who visited the ship to attend to the sick men, and who was the only person among those attacked to escape with his life.

The S.S. *Simla*, a hospital ship conveying invalids from South Africa to England, arrived at Southampton on March 13th, 1901. She had touched at Plymouth, where a case of enteric fever had been landed. No suspicious cases of illness were reported by the master or surgeon of the vessel, although it afterwards transpired that two days after leaving Cape Town a lascar consulted the ship's surgeon in reference to a swelling in the groin. Though at first the suspicion of plague was aroused the idea was dismissed, and no mention was made of the case when the usual questions were put at Plymouth and Southampton. The lascar on landing at Southampton sought advice at the South Hants Hospital as to the swelling in his groin. Previous to this, Dr. Harris, at that time Medical Officer of Health, had asked the hospital authorities to inform him if any cases of glandular swelling presented themselves for treatment. The lascar's case was therefore brought to Dr. Harris' notice, and when the swelling was incised to evacuate the abscess, material was taken and sent to the Board for examination. Dr. Klein was able to say distinctly that the man's illness was due to plague. He was accordingly isolated at once, and all other precautions taken. The man made a good recovery. He was a baker's "mate," and as he is said to have been in the habit of catching rats on board the *Simla*, it is inferred that he had handled an infected rat. Some dead rats, it is stated, were found on the *Simla* a few days after leaving Cape Town, but there was no general mortality among the ship rats. The facts of the *Simla* case were carefully investigated by Dr. Reece on behalf of the Board. No further cases of illness of a sort suspicious of plague occurred at Southampton, nor among any persons who had travelled on board the *Simla*.

The S.S. *Highland Prince*, from Rosario, with a cargo of wheat, arrived in the Tyne on January 11th, 1901. Information regarding this vessel had been telegraphed from South America to the effect that an outbreak of illness resembling plague had occurred on board during the voyage out from Antwerp and London. It appears that she left Antwerp on August 30th, 1900, and called at London to complete cargo. She left the Thames on September 8th. On October 8th, on arrival at Bahia, she reported that she had sickness on board, and on reaching Montevideo on October 12th she reported that five deaths had occurred during the voyage, including the captain, the mate, and the cook. The last named was the first to be attacked, and his illness dated from September 28th, three weeks after leaving London. The main features of the illness were fever and glandular swellings. It is stated that dead and dying rats had been observed on the ship during the voyage, and that many of these had been thrown overboard. The

ship was disinfected at Montevideo, clothing and effects were passed through a steam disinfector, and other precautions were taken. But notwithstanding this, on reaching Rosario, two further cases were reported. The ship was again disinfected, a cargo of grain was taken on board, and she sailed, on December 4th, for the Tyne, touching at Las Palmas on January 1st, 1901. As stated above, she arrived in the Tyne on January 11th, 56 days having elapsed since the occurrence of the last case. Every care was taken in the Tyne to prevent rats leaving the ship, and after the unloading of cargo was completed she was again thoroughly disinfected. Several rats were caught and examined, but the bacteriological investigations conducted by Dr. Klein failed to find any proof that the animals were infected by plague.

The S.S. *Scotia* arrived at the mouth of the Thames on August 5th, 1901, from Yokohama, having called at Kobe, Shanghai, Foochow, Hong Kong, Singapore, Penang, Colombo, Suez, Port Said, and Marseilles. She left Yokohama on May 27th, and on June 10th a coal-trimmer became ill with fever and bubo. He was put ashore at Foochow for observation at the hospital, and the vessel and all the effects of the crew were disinfected by the Foochow authorities.

On arrival off Gravesend all the crew were inspected, but nothing of a suspicious nature was discovered by the port medical officer. The vessel and her crew, however, were kept under observation during the time she was in the port of London, but no illness of a suspicious sort was observed.

The S.S. *Peninsular*.—This ship, according to telegraphic accounts published in the papers, was reported to have landed two plague cases at Frioul, the Marseilles quarantine station, on November 18th, 1901, and to have then sailed direct for the port of London.

The vessel, which belongs to the P. & O. Company, left Bombay with eight officers, 164 crew (only 50 of whom were Europeans), and 68 passengers, on November 2nd, calling at Aden, Suez, Port Said, and Marseilles, reaching the latter port on November 17th. The day before her arrival an Arab coal-trimmer (from Muscat) came to the ship's surgeon suffering from a bubo in his groin, with infiltration of the surrounding tissues. Next day he was seen by the port medical officer of Marseilles, who took some material from the swelling for bacteriological examination. The following day the patient was ordered to land; he was, however, well enough to walk to the boat which conveyed him to hospital. On November 16th another sailor, a lascar, consulted the ship's surgeon regarding enlarged inguinal glands, associated with eczema of the scrotum. This man was also ordered ashore by the Marseilles port medical officer, on the ground, as in the former case, that there was suspicion of plague. To this opinion the master of the ship and the surgeon dissented, and instead of proceeding to the quarantine station to undergo 10 days' observation, the ship sailed for London. These facts were telegraphed to the P. & O. Company in London, who

made inquiries by wire through their agent in Marseilles as to the result of the bacterioscopic investigation of the material from the first case mentioned above. On November 23rd a telegram was received in London to the following effect:—"Result of bacteriological examination shows plague without doubt." Both patients made a speedy recovery. The quarters which the two men had occupied were disinfected, and all articles regarded as infected were burnt. The *Peninsular* touched at Plymouth on November 24th, when all on board were inspected and found well by the port medical officer, who communicated at once with the medical officer of the port of London, whither the vessel proceeded. On arrival off Gravesend on November 25th all were again inspected, disinfection of clothing and effects was performed, the names and addresses of the passengers and crew were taken, and the ship went up the river to the docks, where the usual precautions to prevent the landing of rats were taken, and on discharge of the cargo arrangements were made to fumigate the vessel for the destruction of rats.

The S.S. *Goorkha.*—This vessel left Calcutta on November 19th, 1901, and touching at Madras, Colombo, Aden, Suez, Marseilles, and Plymouth, arrived at the mouth of the Thames on December 29th; she had on board a crew of 292, 12 passengers, and a mixed cargo. At Aden the crew of the *Dilwara*, numbering 89, who had travelled from Bombay in the *Patiala*, were transhipped on board the *Goorkha.* It came to the knowledge of the Egyptian Quarantine Board that an alleged death from plague had occurred on board the *Patiala* between Bombay and Aden. Consequently the men transferred to the *Goorkha* were regarded as "contacts," and a strict examination of all on board the latter ship was made on its arrival at Suez, notwithstanding that the ship's surgeon declared all well. No case of suspicious illness was discovered on the *Goorkha*, which passed through the Suez Canal "in quarantine." While on the voyage to Naples from Port Said one of the Asiatic seamen transferred from the *Patiala* was reported to be ill with suspicious sickness, attended with pneumonia, on December 12th. In consequence, when the vessel arrived at Naples the authorities refused her pratique, and she steamed on to Marseilles. Just before reaching the latter port the patient died, his illness having lasted four days; his body was committed to the deep. The port authorities at Marseilles sent the *Goorkha* to Frioul, where she re-coaled "in quarantine," sailing for London on December 20th; she touched at Plymouth on December 28th, when the port medical officer found all well on board. The usual precautions were observed and she continued her voyage, arriving at the mouth of the Thames, on December 29th, where the ship and all on board were again inspected and found well. As a precautionary measure all the clothing and effects of the Asiatics were landed at Denton and passed through the steam disinfector. The men's quarters were washed down with a solution of corrosive sublimate (1 in 1,000). The part of the ship where the sick man had been was thoroughly disinfected, as also were the bilges and closets. Arrangements were made for a daily medical inspection of the crew while in dock, and

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for killing rats on board. No cases of suspicious illness were reported in connexion with the *Goorkha* after this.

The S.S. *City of Bombay* arrived off Gravesend on December 19th, 1901, from Calcutta, with a crew of 185 and five passengers, as well as a mixed cargo. She carried a surgeon. On arrival at the mouth of the Thames the port medical officer of health boarded the vessel and was informed by the ship's surgeon that so far as he was aware all on board were well. No deaths had occurred on the vessel during the voyage. The health of all on board had been excellent with the single exception of a native coal-trimmer who, just prior to arrival at Suez, developed symptoms of pneumonia. The authorities of the Egyptian Quarantine Board at Suez on microscopical examination of the sputum regarded the case as suspicious of plague, and the patient along with a native pantryman who had a swelling in his groin, but of which he had made no complaint, were landed at the sanitary station at Moses Wells, where the ship, including the forecastle and hospital cabins, was disinfected. The effects of the crew were taken ashore and passed through a disinfector. The ship then proceeded through the canal in quarantine. A later report from Suez stated, however, that the result of a careful bacteriological investigation of material from the two cases landed from the *City of Bombay* was negative as to plague. Notwithstanding this, the usual precautionary measures were taken at the port of London, especially with regard to the prevention of rats leaving the ship and for the destruction of these rodents when the cargo was unloaded.

The S.S. *Clan Robertson* arrived off Gravesend on December 22nd, 1901, from Calcutta, with a crew of 199 and a general cargo. She did not carry a surgeon. On the usual inspection by the port medical officer of health, all on board were found well, but the master reported that at Suez a lascar was found to be suffering from an inguinal bubo and fever, for which no obvious cause could be discovered. The Egyptian Quarantine Board's officers considering the case suspicious of plague, sent the ship to Moses Wells sanitary station to undergo disinfection after disembarking the sick man. When this was completed the ship passed through the canal "in quarantine." Later reports from Suez show that the result of the bacterioscopic examination of material taken from the lascar's bubo proved that the man had not been suffering from plague.

With reference to plague infected rats. The S.S. *Rembrandt*, regarding which mention was made on page 308, arrived at Bristol from Smyrna on January 20th, 1901, and began to unload her cargo of grain at the quay. No illness had occurred among the crew during the voyage of 18 days. The Medical Officer of Health, Dr. Davies, was informed on January 22nd that during the unloading some dead rats had been found among the grain. Bacteriological examination made locally pointed to the fact that the rats were plague-infected. Consequently dead rats from the *Rembrandt* were forwarded to the Board for investigation by Dr. Klein, who reported that without doubt the animals had

died from plague. It may be remarked that by direction of Dr. Davies special precautions had for some months previous to this been taken to prevent the landing of rats from ships. While the investigations were being carried on, the ship was removed from the quay, but as soon as the diagnosis of plague was confirmed she was taken to the mooring station. No cases of illness occurred among the crew or among the 77 dock labourers who were employed in the process of unloading. Though undoubtedly the ship rats on board the *Rembrandt* were infected by plague, no transference of infection from rat to man supervened, and no evidence was adduced to show that the shore rats had received the infection. Bristol so far as is known remained free from plague.

In continuation of the Board's efforts of past years to prevent the importation of plague from abroad by ships arriving in this country, a number of seaports were revisited by Medical Inspectors with a view to ascertaining the preparedness of the local port sanitary authorities in this respect, and to confer with the officials as to precautionary measures. The following Medical Inspectors, during 1901, performed this duty, viz., Drs. Bulstrode, Reece, Johnstone, and Manby, and the ports visited were Blyth, Tyne, Sunderland, Tees, Weymouth, Plymouth, Fowey, Falmouth and Truro, Bridgwater, Bristol, Gloucester, Newport (Mon.), Cardiff, Swansea, and Liverpool. Considerable improvement has of recent years taken place in the administration of our ports. Some, however, still lag behind, and in so far as the administration of those ports by their local port sanitary authorities falls short of what it ought to be, so far is the danger of importation of exotic disease into this country increased. It can be stated with certainty that the majority of the port sanitary authorities of England and Wales are now taking an active and intelligent interest in the responsible duties which devolve upon them, and the majority of them are provided with equipment and administration to cope with any imported cases of plague, cholera, or yellow fever.

(B.) *Plague and Suspected Plague on Shore.*

During 1901 thirteen instances were reported to the Board of illness exciting suspicion of plague, and in regard of which the aid of the central authority's bacteriological expert was sought to confirm or disprove the diagnosis. In only two of these instances was the illness in question found to be true plague, viz., at Cardiff in February and at Liverpool in October. Details of these outbreaks are given below. At Cardiff the outbreak was limited to a single confirmed case and another which was doubtful. But some alarm arose when it was found that the dock rats at Cardiff had contracted the disease. Fortunately, beyond the single case just mentioned and the other doubtful one, plague at Cardiff remained limited to rats. At Liverpool the outbreak comprised 11 cases which were believed to have been instances of true plague; eight of them proved fatal. In only two cases was definite bacteriological proof forthcoming as to their true nature. It is remarkable that at Liverpool no evidence whatever was obtained

that the local rats had been infected by plague before, during, or after the disease had appeared in man. A consideration of these two outbreaks, and of the behaviour of the Glasgow outbreaks of 1900 and 1901, supplemented by other evidence collected broad, as well as by our own experience of plague infection on board ship, leads to inference that the amount of danger of transfer of plague infection from rat to man is by no means so great as has been assumed by some authorities; and that after all it may be that man is more likely to give the rat plague than the rat to give the disease to man.

Although particulars of the Cardiff outbreak appeared in the "plague volume" issued in October, 1902, to which reference has already been made, a statement of the facts may here be repeated for the convenience of readers who may not have seen the more detailed account.

(a.) *Instances in which the Diagnosis of Plague was Bacterioscopically Confirmed.*

Cardiff.—On January 31st, 1901, the Board was informed by telegraph by Dr. Walford, Medical Officer of Health, that a case suspected to be plague had occurred at Cardiff, and that material from the patient was being forwarded for bacterioscopic examination. Meanwhile investigation was made locally by Dr. Savage, bacteriologist to the Glamorgan County Council, with the result that the diagnosis of plague was confirmed, and later on this was corroborated by Dr. Klein on behalf of the Board. Dr. Reece was at once despatched to Cardiff, and the following facts were ascertained:—A man employed at a flour mill close to the docks complained of illness on January 27th; his symptoms having excited suspicion, Dr. Walford was asked to see the case in consultation. The patient died on the 31st, and was buried next day, February 1st, with due precautions. On investigation it appeared that about a fortnight before he fell ill rats had been observed dying in somewhat unusual numbers at the mill where he worked, and that he had carried some of these dead animals to the mill furnace to destroy them. It was considered that he had thus probably through some abrasion on his hands become inoculated by the plague-stricken rats. On February 1st another man came under suspicion who worked also at a mill, but not the same as the first mentioned. This second patient had been engaged in removing floors while searching for dead rats, and he also had handled their bodies in conveying them to the mill furnace. He had a sore on one of his fingers and a swelling in the axilla; his illness only lasted a few days. The diagnosis, however, in this case was not bacterioscopically confirmed, and it is very doubtful if it can be reckoned as a case of plague.

Examination of some dead rats sent from Cardiff to Dr. Klein showed that these animals had died from true plague, Dr. Savage having also, before this, arrived at a similar conclusion from bacterioscopic investigation. A campaign against rats was at once begun, and some thousands were killed within a short time,

Careful medical investigation failed, however, to discover any further cases of human plague, and the outbreak was therefore limited, as has already been said, to one fatal case and to another mild attack of illness which, however, could be medically accounted for apart altogether from plague.

For full details of this appearance of plague at Cardiff in January, 1901, the reader is referred to the special plague volume issued in October, 1902.

Liverpool.—During the two previous years a careful watch had been kept by the officers of the Port Sanitary Authority upon shipping which arrived in Liverpool from plague-infected ports. Certain cases, in which suspicion arose, had during that period been removed from various vessels to the port isolation hospital for observation. But, so far as is known, no case of true plague had occurred within Liverpool up to September, 1901. On September 29th, 1901, C. M., a lad aged 19 was admitted to the Liverpool Workhouse hospital suffering from fever and buboes, with a history of recent injury in the football field. On October 2nd the surgeon to the hospital excised the swollen glands, but the patient died about 24 hours later, his death being certified as due to "septicæmia." A post-mortem examination had been made, but "no gross changes in any of the internal organs" were discovered. After the operation on October 2nd, though at the time no suspicion of plague was entertained, the excised glands were handed for bacterioscopic examination to Dr. Griffiths, a scholar of University College, Liverpool. On October 18th this gentleman informed the workhouse surgeon that he believed the case had been one of plague. On the suggestion of Dr. Hope, the Medical Officer of Health for the city and port, who had been informed of the facts, the bacteriological results were submitted to Professor Boyce and Dr. Balfour Stewart, bacteriologists of experience, but these experts were not then able to confirm Dr. Griffiths' diagnosis, consequently Dr. Hope communicated with the Board, who asked that specimens of the cultures relating to the case should be sent for examination by Dr. Klein. But before this investigation was definitely completed a message was telegraphed to the Board on October 26th by Dr. Hope that two additional cases had occurred which left little doubt as to their real nature. On receipt of this intelligence Dr. Bulstrode was instructed to proceed the same day to Liverpool to confer with Dr. Hope as to the outbreak.

From inquiries made by Dr. Hope it transpired that several suspicious deaths had occurred in Liverpool about the end of September and beginning of October, but as to which no connexion could be traced with the case of C. M. above mentioned. Subsequent careful investigation, however, revealed the fact that four families living in the same locality, and having somewhat intimate relations with one another, had been invaded by illness of a kind that suggested plague. The facts as to these are briefly as follows :—

I. *The K. family.*—Mrs. K. died on September 28th, and her death was certified as "Influenza six days, cardiac

failure." On October 3rd Mrs. K.'s younger daughter died, and the cause of death was certified as "Influenza seven days, congestion of the lungs." Mrs. K.'s elder daughter was taken ill, not long after her mother and her sister's death, with fever and swelling in the axilla; ultimately an abscess formed in the armpit, and this was still suppurating when the case came to Dr. Hope's notice towards the end of October.

II. *The L. family.*—On October 18th Mrs. L. died somewhat suddenly, her death being certified from "Cerebral apoplexy." She had done the washing for the K. family up to her attack, and had laid out Mrs. K.'s dead body.

III. *The J. family.*—Mrs. J. and two junior members of this family were attacked by illness and were removed to the isolation hospital on October 26th. This family was on friendly terms with the K.'s, and the young people of the two families habitually associated together. One of these two children died in hospital from "asthenia" some time after the acute symptoms had subsided. The illness was at first thought to be enteric fever.

IV. *The W. family.*—Three junior members of this family were attacked during October by fatal illness, thought at first to be "typhus fever," and for which two of them were conveyed to the isolation hospital. One boy died at home on the 23rd of October—he was too ill to be removed with his brothers; another died at the hospital on October 25th, and the third on the 26th. The K.'s house was close to the back of W.'s house, and there was communication between the families.

Material was taken post-mortem from two of these cases and submitted to Dr. Klein for examination. He reported on October 29th that plague had been the cause of death. As soon as this report was received its contents were notified to the Foreign Office, so that information could be conveyed at once to the Signatories to the Venice Convention.

As has been stated, these four families resided in the same locality and near to each other. The lad C. M., who died at the workhouse hospital on October 3rd, lived in another part of the city, and, as has been said, there was no apparent connexion between his case and those included in the four above-named families.

Although bacteriological proof of plague was obtained in only two of the cases, yet, looking to the nature of the symptoms* of the other cases and their intimate relations with one another,

* Influenza, typhus fever, cerebral apoplexy, cardiac failure, and congestion of the lungs have all been "headings" under which plague cases have been classed elsewhere in the earlier stages of epidemics in one or another country.

there can be little doubt that the above-named had been suffering from an illness common to them all, and this was plague. If the suspected case of C. M. be also included, we have between the end of September and the end of October a total of 11 cases, of which no less than eight proved fatal, a case mortality of 72·7 per cent.

Diligent search was made in the locality where these cases occurred, but no others of a suspicious kind were brought to light. The last of the patients removed to the isolation hospital was certified to have recovered on November 8th, and on the 18th of November the port and city of Liverpool were officially declared to be free from plague under the terms of the Venice Convention of 1897.

It is interesting to note that no evidence was forthcoming as to infection locally of rats by plague, though careful search was made not only in the invaded houses but throughout the city. Many rats were examined at the Thompson-Yates Laboratory with the view to discover if the bacillus pestis was present in them, but in no case was a positive result obtained.

In addition to the removal of the sick to the isolation hospital, and the segregation of contacts, to whom compensation was paid for loss of effects and absence from work, the invaded houses were thoroughly disinfected, the paper stripped from the walls, and the bedding and clothing of the patients burnt. The whole of the ashpits in the streets where the invaded dwellings are situated were cleansed and disinfected; the drains and sewers were thoroughly flushed with powerful disinfectant solutions. The day and sunday schools in the infected area were temporarily closed for about three weeks. Destruction of rats throughout the city was carried on. Previous to the outbreak of plague steps had been taken in Liverpool to destroy the rats infesting the sewers, and under the instructions of Dr. Hope an experienced sanitary inspector was directed to visit the wharves and warehouses where rats were likely to exist, to advise the owners and occupiers as to the best methods of exterminating these rodents. The market superintendent too had been urged to use frequent and stringent means for killing rats which were known to infest the markets.

Prior to the appearance of plague in Liverpool systematic steps had been taken for about two years to prevent the landing of rats from vessels which had come from infected ports. Among other measures, mooring ropes and cables were required to be furnished with discs or guards to prevent the landing of rats.

When it became known that plague had invaded Liverpool some foreign nations began to impose severe quarantine restrictions upon arrivals from that port, causing much inconvenience as well as pecuniary loss. Dr. Hope had at once placed himself in communication with the consular representatives of the foreign powers at Liverpool and explained to them the facts of the outbreak and the measures which had been taken to suppress it; and later, with a

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view to disarm the fears of those nations who were most apprehensive, he submitted to the consuls details of the precautions which were being taken in respect of vessels leaving Liverpool for foreign ports. These precautions included a medical examination of the crew and passengers before departure, and inspection of the clothing and bedding and personal effects of those on board; where necessary these articles were disinfected. An undertaking was given that no susceptible goods* (as defined by the Venice Convention) would be shipped.

A certificate, signed by the port medical officer of health, to the effect that these precautions had been taken before departure was given to the master, and when required the ship's holds and quarters were disinfected by fumigation by the port authorities' officials, and a special certificate given to that effect. All of the above measures involved no cost to the owners of the vessels, but were carried out at the expense of the port sanitary authority. As a result, vessels thus dealt with were saved much useless detention and many burdensome restrictions on arrival in foreign ports. The certificates were printed in seven languages,† and were found especially useful in respect of ports in the United States and South America.

To carry out these plague prevention measures six additional medical men were appointed to assist the three permanent port medical officers, while 25 other assistants were temporarily added to the sanitary staff.

With regard to the way in which Liverpool received its plague infection opinions are divided. Two sources are suggested. The first of these refers the importation of the infection to Glasgow, where Mrs. K.'s two daughters paid a visit to friends during the month of August. It will be remembered that Mrs. K., so far as can be discovered, was the earliest victim of the outbreak. In this connexion it is worth noting that the two daughters who visited Glasgow, whence the infection is supposed to have been derived, suffered from the malady after their mother, who had not been to Glasgow. If the infection had been contracted at Glasgow it was to be expected that the daughters would have suffered first. On the other hand, it cannot be denied that plague existed in Glasgow at the time the two girls were visiting there; for some five recognised cases had then been reported; but no connexion between any of these five cases and the house where the K.'s were visiting has been traced.

The second opinion refers the introduction of the plague infection to a policeman who lodged with the K. family, but who himself was not known to have had any suspicious symptoms. Part of this man's duty was connected with a mortuary at the

* These include (1) body linen and clothes that have been worn, or bedding that has been used; (2) bags; (3) used sacks, carpets, and embroidery that has been used; (4) raw hides, untanned and fresh skins; (5) fresh animal refuse; claws, hoofs, horsehair; hair of animals generally, raw silk and wool; (6) human hair.

† English, French, German, Russian, Italian, Spanish, and Portuguese.

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Liverpool docks, where the bodies of sailors, including Asiatics, were conveyed prior to burial. He had to strip off the clothing of men found dead, and the suggestion is that if an Asiatic sailor suffering from unrecognised plague died in the docks, his body would be handled by this policeman, who might in this way have come into contact with infection, and might have conveyed it to the K.'s house, in which he lodged.

(b.) *Instances of Suspected Plague in which Bacteriological Examination did not Support the Diagnosis of Plague.*

(1.) *Bristol.*—On February 7th a man died at the Bristol Royal Infirmary, where he had been under treatment for about 10 days, suffering from what was regarded as an erysipelatous condition of the face, with some swelling in the neck. His illness began on January 23rd, five days before he came to the hospital. He is stated to have developed a "typhoid condition," and there was enlargement of his glands. The Medical Officer of Health, Dr. Davies, saw the patient at the hospital on January 30th. The man, so far as is known, had had no connexion with shipping at the docks, nor had he been away from Bristol for some considerable time. His last employment had been at some lead works. When he died a post-mortem examination showed the spleen to be slightly enlarged. Material was taken by Professor Kent, of Bristol University College, for bacterioscopic investigation, and part of such material was forwarded for examination to Dr. Klein, the Board's bacteriological expert. He, however, reported that his results were altogether negative as regards plague.

This case, though at first offering grounds for suspicion, may be definitely stated not to have been plague.

(2.) *Plymouth.*—Towards the end of February Dr. Williams, the Medical Officer of Health, reported to the Board a case as to which the medical attendant had been entertaining suspicion that the illness might be plague. The patient, a Jewish pawnbroker, became ill on February 16th with rigors, headache, and fever, attended with prostration. Painful glandular swellings developed in his armpit and groin. Material taken from this patient was sent to Dr. Klein for bacterioscopic examination, and he reported that the illness was due not to the plague bacillus, but to staphylococcic infection. What had added to the suspicion of the medical attendant was the fact that the pawnbroker had in the course of his business to handle a considerable amount of clothing that had already been worn, and hence the possibility that plague infection had been contracted through the instrumentality of infected clothing from some unknown or concealed case. In the opinion of the medical officer of health, the septic illness from which the man suffered was due to absorption of staphylococcic infection, through abrasions upon the patient's fingers.

(3.) *Islington.*—On April 7th a boy who had been ill for some days was admitted to St. Bartholomew's Hospital suffering from

fever, along with enlargement of the femoral glands on both sides, a sore being present on one of his feet. In view of the suggestion which had been made to the hospital by the Board that all cases in which glandular swellings were observed should be carefully investigated, it was deemed advisable, as a precautionary measure, to seek the assistance of the special plague clinical expert employed by the London County Council. This specialist after examination of the patient, was of opinion that the case was not one of plague, but was due to septic infection arising from the sore on the foot. However, material taken from the glandular swelling was sent to Dr. Klein for investigation. His report stated that neither morphologically, culturally, nor from inoculation experiments on animals could he find any evidence of the existence of the plague bacillus in the patient. The case was, therefore, not one of plague. While the bacterial investigation was in process the boy was removed from St. Bartholomew's Hospital to the South Eastern Fever Hospital of the Metropolitan Asylums Board, where arrangements had been previously made for the reception of any suspected cases of plague occurring in the London Metropolitan district. At the same time the patient's family were temporarily regarded as "contacts," and were removed for observation to a house which had been made ready to accommodate such cases. The house in which the patient had lived was then thoroughly disinfected by the officers of the local authority, and the personal effects of the family—clothing and bedding—were passed through a steam disinfector. The boy soon recovered, and no further cases of illness occurred among those associated with him or his family.

(4.) *Hucknall Torkard* (*Notts*).—The Board received on April 7th from Dr. Jones, the Medical Officer of Health for the Hucknall Torkard Urban District, some blood and pus taken by a local practitioner from a patient who had been ill for a month suffering from acute symptoms and from enlarged glands in the cervical, femoral, and gluteal regions. These glandular swellings had suppurated, and, therefore, the medical attendant, having suspicion that the case might be one of plague, deemed it advisable to have a bacteriological examination made. Dr. Klein reported, however, that the results were wholly negative as regards plague.

(5.) *Kilburn* (*Willesden Urban District*).—A non-commissioned officer came home from Woolwich to his mother's house in Willesden on May 11th suffering from slight rise in temperature and an enlarged gland in his right groin. He had also some tenderness over the liver. There was no local irritation on the feet or genitals to account for the glandular swelling. He had not been out of England. His private medical attendant became suspicious as to the nature of the case and called to his assistance Dr. Cantlie, one of the clinical plague experts employed by the London County Council. The opinion of this expert was to the effect that the case might be one of pestis minor, and the Board was accordingly notified to that effect. Some material from the swollen gland was obtained for examination by Dr. Klein, who reported that the results were entirely negative as regards plague. Pending the receipt of Dr. Klein's

report, the man was removed to a vacant pavilion at the Willesden isolation hospital, and those persons who had been in contact with him were transferred to a house which was secured as a "shelter." Dr. Sweeting, on behalf of the Board, visited Kilburn and conferred with the local officials as to precautionary measures to be taken should the bacteriologist prove the case to be one of plague. The evidence negatived the diagnosis of plague, and there were no further developments of illness causing suspicion.

(6.) *Ealing.*—On May 17th a medical man at Ealing addressed a letter to the London County Council's Medical Officer of Health, stating that a patient of his had returned a week ago from the Riviera suffering from symptoms which he regarded as suspicious of plague, and asking that a plague expert might be sent to examine the case. The letter was sent on to the Board, who instructed Dr. Sweeting to investigate the case. This he did the same day, finding the supposed plague case suffering from a typical attack of enteric fever, and with nothing to excite suspicion of plague. But the nurse in attendance was feverish and complained of painful swellings in both groins. Dr. Sweeting obtained some blood and gland juice by puncture, and sent the material to Dr. Klein, who reported that he could find no bacteriological evidence of plague. Dr. Sweeting was of opinion that the clinical history of the case did not support a diagnosis of plague. The nurse was subsequently removed to the Ealing Cottage Hospital, where the surgeons attributed the glandular inflammation to irritation from a sore on the foot. Neither of these two cases then turned out to be plague.

(7.) *Sheffield.*—A woman, aged 24, went on November 5th, 1901, to Sheffield from Liverpool to act as servant at a hotel. She was taken ill next day with feverish symptoms, sore throat, and some enlargement of the glands in the neck, axilla, and groin. She was removed to hospital on November 10th. Delirium occurred during her illness, which proved fatal on November 14th, the ninth day of the attack. A post-mortem examination was made in the presence of the medical officer of health, to whom the case had been reported. Patches of pneumonia were found in both lungs, the spleen was enlarged, and there were hæmorrhages in both kidneys. Specimens from the lungs, spleen, liver, and the enlarged glands were forwarded to the Board for bacterioscopic examination by their expert, Dr. Klein, whose report, however, was negative as regards plague. As the patient had travelled to Sheffield from Liverpool, where cases of plague had been recognised at the end of October, suspicion naturally arose as to the character of the disease. Pending receipt of the bacteriological report the clothing and bedding of the patient were thoroughly disinfected by the sanitary officials of the Sheffield Corporation, as a precautionary measure.

(8.) *Manchester.*—On November 11th the Medical Officer of Health for the City of Manchester reported to the Board two cases in which suspicion of plague had arisen. The first of these, a boy, was taken ill suddenly on October 30th with meningeal symptoms and some pneumonia. He was isolated in the fever hospital

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where he recovered after an illness lasting about 10 days. The second case occurred in the practice of the medical man who had reported the first, the illness also beginning on October 30th. The malady at first was regarded as typhus. Bacteriological examination made locally suggested a diagnosis of plague, but on specimens of the material being forwarded by request to the Board, Dr. Klein stated definitely that his results negatived a diagnosis of plague. These cases gave rise at first to strong suspicion since the clinical characters of the illness were not unlike those associated with plague, but, as has been said, bacterioscopic investigation proved beyond doubt that the malady in question was not plague.

(9.) *London.*—On November 14th, 1901, the Medical Officer of Health for the London County Council reported to the Board's Medical Department the case of a man resident at Chiswick who had been employed on board a steam tug on the Thames, and who had been admitted to the West London Hospital suffering from illness, attended with buboes, and suspected to be plague. Dr. Cantlie, one of the experts employed by the London County Council, had seen the case, and had formed the opinion that the ailment was very likely to be of the nature of plague. Material taken from the glandular enlargement was forwarded to Dr. Klein for examination, but he was unable to find any evidence to support the diagnosis of plague.

(10.) *Huntingdonshire.*—On December 11th, 1901, the Board received information from a private medical practitioner in Huntingdonshire that he had under his care a grain merchant suffering from fever and bubo for which no apparent cause could be detected. Since suspicion in his own mind had arisen as to plague, he invoked the Board's assistance. Through the medical officer of health some material from the bubo was obtained and forwarded to Dr. Klein for examination, but his results negatived the diagnosis of plague. Later it was thought that the glandular swelling was due to irritation on one of the toes.

(11.) *Gloucestershire.*—On December 17th, 1901, while one of the Board's Medical Inspectors was making an official visit in a locality in Gloucestershire, he was informed by a medical practitioner that he had had a series of some seven cases of glandular abscess within a comparatively short period of time. Most of these cases had passed through their acute stages and their abscesses were nearly healed. But in one a gland was still inflamed, suppuration not having yet occurred. In view of the possibility that this adenitis might turn out to be due to "bubonic" infection, the Inspector advised that material should be obtained from the case and forwarded to the Board for bacterioscopic examination by Dr. Klein. This was done, but the results were entirely negative as regards plague.

Owing to the occurrence, during 1901, of more than one case at first suspected to be plague, in districts lying within the outer

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ring of London, the Board deemed it advisable that the chief sanitary districts in that area should be visited by the Board's Medical Inspectors for the purpose of conferring with, and advising, these local authorities as to the precautionary measures to be taken beforehand, and as to the provisions to be made for dealing with actual plague or suspected plague should it occur.

Drs. Sweeting and Mair were detailed for this purpose, and some 15 districts were visited by them during the summer of 1901. The points to which they chiefly directed the attention of the local authorities were: compulsory notification of all plague cases; facilities for verification of the diagnosis by the official bacteriologist; need for provision for the isolation of infected cases and segregation of "contacts"; disinfection of bedding, clothing, &c., as well as disinfection of invaded houses; preventive inoculation by Haffkine's method; special inspection of common lodging houses; need for local medical men being on the alert, especially medical officers of hospitals and poor law infirmaries, for possible mild cases of plague applying for treatment; destruction of rats; and efforts for removal of nuisances of all kinds. The places visited by the Medical Inspectors included the Boroughs of West Ham and Croydon, the Urban Districts of Acton, Ealing, Chiswick, Brentford, Willesden, Hendon, Hornsey, Tottenham, Bromley, Chislehurst, Beckenham, and Wimbledon, and the Rural District of Croydon.

No. 20.

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Cholera from 1896 to the end of 1901; by Dr. R. Bruce Low.

ON the MANIFESTATIONS of CHOLERA from 1896 to the end of 1901; by Dr. R. BRUCE LOW.

It has been recorded in former reports of the Medical Officer that cholera was epidemic in Europe from 1892 to 1895, during which period the disease was widely prevalent in many other parts of the world. In 1896, too, cholera was epidemic in Egypt; but at the end of that year Europe and the near East became practically free from the disease. While, however, danger from cholera was receding from Europe a new danger was beginning to threaten western nations, plague having shown a tendency to spread westwards from India and the East. In the circumstances the annual abstracts regarding the progress and diffusion of cholera were, for the time being, discontinued in the Annual Reports of the Medical Officer to the Board; and instead attention was given to the behaviour of plague. But, during the years for which no annual summary of the diffusion of the disease was furnished in the annual volume, cholera remained by no means inactive in certain parts of the world. For example, in India during the five years from 1896 to 1900 inclusive no fewer than 2,148,149 deaths were recorded from the malady. Other eastern countries also suffered, though not so severely. In 1901 there was a distinct increase of cholera in several of those areas where cholera is wont to show itself, and, in addition to India, the Dutch East Indies showed a notable increase of the malady; moreover, in the early months of 1902 cholera broke out in the Hedjaz and raged severely among the pilgrims, killing thousands of these persons. Later, while this volume has been preparing for the press, the disease reached Egypt and has carried off some 30,000 of the inhabitants. Cholera has also invaded Palestine in 1902; and other epidemics, some of them on a large scale, have occurred elsewhere during 1902, *e.g.*, in the Philippine Islands, China, Japan, the Straits Settlements, Dutch East Indies, Asiatic Russia, and Korea.*

Seeing that cholera has been severely epidemic in Arabia and Egypt, almost at the gates of Europe, it has been deemed advisable to take up again and to continue the reports of the Medical Department on cholera diffusion.

The present report is intended to sketch briefly the incidence of cholera, so far as information could be obtained, throughout the world during the period from 1896 to the end of 1901.

* The details of these recent outbreaks will appear in the Annual Report of the Medical Officer for 1902.

INDIA.

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Cholera from 1896 to the end of 1901; by Dr. R. Bruce Low.

India is popularly known as the home of cholera, and many of its provinces and native states suffer from annual epidemics of the disease. In the subjoined table is given a statement as to the number of cholera attacks and deaths recorded in each of the provinces and native states of India during each year from 1896 to 1901 inclusive.

From this table it will be seen that there were considerable fluctuations in the amount of cholera deaths certified in the several years. The heaviest mortality was experienced in 1900, when over three-quarters of a million of lives were sacrificed to cholera in India, more than half of the total number being referred to the Presidency of Bengal.

In 1901 there was a diminution in the amount of cholera recorded in India, the reduction being most marked in the Presidencies of Bengal and Bombay, especially in the latter.

Altogether nearly two and a half millions of lives have been lost from cholera in India during the six years 1896 to 1901.

TABLE showing the number of DEATHS from CHOLERA in the Provinces and States of India year by year from 1896 to 1901 inclusive.

Province or State.	Population (1901 Census).	1896.	1897.	1898.	1899.	1900.	1901.
Bengal	78,493,410	226,824	196,247	65,020	107,678	345,878	110,753
Bombay	25,424,235	35,404	57,109	4,368	8,579	163,889	13,600
Madras	38,623,066	47,847	143,445	65,444	29,082	60,662	81,370
The Punjaub and North-West Frontier.	26,880,217	5,146	622	33	1,816	28,260	180
The United Provinces of Agra and Oudh.	48,493,879	69,147	44,208	2,508	8,142	84,960	53,995
The Central Provinces	11,873,029	52,985	57,131	7	76	63,114	*
Assam	6,126,343	17,042	33,240	11,149	8,380	23,761	7,468
Berar	2,754,016	12,264	10,122	—	541	18,375	17
Rajputana	9,723,301	3,797	1,496	6	498	28,719	*
Central India.. ..	8,501,883	15,766	13,202	2	—	20,450	*
Hyderabad State ..	11,174,897	525	1,039	6	—	3,831	*
Mysore State	5,538,482	2,100	4,248	1,193	123	779	*
Coorg	180,607	49	106	8	—	—	*
Lower Burma ..	5,546,265	2,959	8,538	2,972	4,942	3,440	3,552
Upper Burma ..	3,584,229	?	?	?	4,842	41	1
Ajmer Merwara ..	476,912	12	19	1	1	4,842	*
Total	—	471,779	555,035	152,703	171,410	797,222	†

* Returns for 1901 not received.
† Total incomplete.

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Cholera from 1896 to the end of 1901; by Dr. R. Bruce Low.

During the period in question occasional instances only have occurred of ships from India technically or actually infected by cholera arriving in English or other ports (*see* pages 355 and 356).

FRENCH INDIA.

In French India, with an estimated population of 300,000, which comprises Pondicherry, Karikal, Chanda Nagor, and Yanaon, there came to the notice of the local officials some 1,297 cases and 1,075 deaths from cholera during 1900; but it is calculated that these figures very much under estimate the total amount of cholera that actually occurred.*

PERSIA.

In 1899 certain localities along the eastern coast of the Persian Gulf became infected at the time when cholera was raging on the opposite shores of Arabia; among these localities was Bendir Bouchir a Persian port on the north-east coast of the Gulf. In 1900, during June, cholera was reported to have appeared at Kishm.

BALUCHISTAN.

At Gwadar, a small town on the coast of Baluchistan, there occurred a sharp outbreak of cholera in August, 1899; during the four weeks ended 31st August 368 deaths were reported. It is alleged that the cholera infection was imported from Karachi.

AFGHANISTAN.

This country experienced a sharp outbreak of cholera in 1901. The disease is stated by the Russian authorities to have broken out at Djebal Abad and Cabul at the beginning of June, and to have by its ravages at once produced such alarm as to cause the Emir and his family and court to flee from the capital followed by his troops of the guard. All Government establishments were, it is stated, closed. No definite figures have been published as to the number of cases and deaths at Cabul, but it is stated that during July there were 140 cholera deaths daily. One account gives the total cholera deaths from the beginning of June to the beginning of August as 4,500. Persons who fled in panic from Cabul are reported as having carried cholera infection with them to other places, including Ghazni, Kandahar, Jalalabad, Badakshan, Faizabad, Shignan, and to some localities between Cabul and the Kara Kotal Pass. But no details as to these outbreaks outside Cabul have been received.

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* Le Cholera Asiatique dans les Etablishments Français de l'Inde en 1900, par M. le Dr. Bussière, Médecin Major de 2me classe des Troupes Coloniales; Annales d'Hygiene et de Médicine Coloniales, No. 1 1903.

A fresh recrudescence of cholera in Afghanistan is stated to have occurred in November, 1901, but no official report upon it has been issued.

CEYLON.

From its vicinity to India Ceylon is liable to the importation of cholera infection by means of the large numbers of coolies brought to the plantations on the island from the mainland. Outbreaks thus arising were noted in 1896, 1897, 1898, and 1899. In 1900 Ceylon practically escaped visitation by the disease, but in 1901 cases occurred in the Western and North-Western Provinces and in Uva. In all some 150 attacks and 95 deaths were recorded in Ceylon during the year.

THE STRAITS SETTLEMENTS.

Cholera has shown itself in the Straits Settlements in each year of the period under review, viz., in 1896–97–98–99–1900 and 1901, but not in any very large amount. Singapore, owing to its frequent communications by shipping with Chinese and other eastern ports, suffers almost yearly from small outbreaks. For example, towards the end of 1900 there occurred an outbreak, limited in area, during which some 257 cases and 232 deaths from the disease were recorded. During 1901 only 87 cases and 84 deaths from cholera came under observation.

From Singapore cholera was conveyed in November, 1900, to Penang, where 16 cases and 12 deaths followed before the close of the year.

In the Federated Malay States cholera was prevalent in 1901. An outbreak in Lower Perak caused 227 attacks and 201 deaths, and in Selangor eight fatal cholera cases came under observation.

SIAM.

Cholera was reported at Bankok in 1897, when 150 deaths were ascribed to the disease which again appeared in 1899 and 1900. The official reports on these outbreaks are meagre, but in 1900 it was stated in the public press that the mortality was great, and that the disease had spread through almost every province of the kingdom. The king's brother died of cholera in 1900, as also did several Europeans.

COCHIN CHINA.

Cholera was reported from the Saigon District of Cochin China in June, 1897, and in December, 1899. From a report prepared by

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Dr. Kermorgant, of the Health Service of the Colonies, it appears that in Cochin China and Cambodge cholera appears year by year; but that in 1899 its manifestation was of greater intensity than usual. The disease began in Laos in August, and extended to Cambodge in September. It invaded the river provinces of the Mekong, and then appeared in Cochin China in October. In two months 1,304 cases and 1,148 deaths were recorded: But these figures are far from revealing the whole truth, since many cases were never brought to the notice of officials.

THE DUTCH EAST INDIES.

The Dutch East Indies have also year by year suffered from cholera since 1896; except in 1900, when the records are silent as to the presence of the disease. During the five years period, 1896 to 1900 inclusive, 21,588 cases and 13,969 deaths were recorded from cholera in the Dutch East Indies. The numbers for each year are given below:—

Year.	Cholera Cases.	Cholera Deaths.
1896	2,203	1,280
1897	19,156	12,610
1898	144	42
1899	85	37
1900	?	?
Total in 5 years ...	21,588	13,969

In 1901 there was a considerable prevalence of cholera throughout the Islands of Java, Sumatra, Borneo, and Celebes, forming the Dutch East Indies. The figures are admittedly imperfect, but from one or another source it has been estimated that not less than 10,658 cases and 7,414 deaths occurred. The largest number of attacks were referred to Java, and particularly to Sourabaya, which is situated in that island. Of 9,844 cholera attacks in Java 5,635 occurred at Sourabaya, which is one of the chief ports in the Dutch East Indies. It is known that a number of Mohammedan pilgrims proceed each year from the Dutch East Indies to the Hedjaz, and during the latter part of 1901, on at least one ship, the s.s. *Anchises*, cholera cases are said to have occurred on the voyage from Java to Djeddah; and on another ship, the s.s. *Inchmoor*, there were six cholera cases between Java and Suez in September, 1901. It has been asserted that the

virulent outbreak of cholera in the Hedjaz of 1902 was due to infection imported from Java, but it has to be mentioned that other sources of infection of the Hedjaz have been pointed out as more probable.

CHINA.

Hong Kong escaped practically from cholera during 1897–98–99, though sporadic cases were reported. This immunity was said in a measure to be due to the habit of the Chinese of boiling their drinking water before use. In 1900 a single fatal case was imported from Saigon in the steamer *Petrarch.* In March, 1901, 11 cholera cases and nine deaths were reported in Hong Kong in connection with a ship which had come from Singapore.

Swatow.—In 1898 several cholera cases came under the notice of certain European medical men in Swatow. But the extent of the outbreak was not known.

Owing to the difficulty of obtaining trustworthy information as to outbreaks of epidemic disease in China, it is impossible to say whether cholera showed itself in any acute form in that country during the period now under consideration. But as regards 1902, from a variety of sources we have now information of a considerable epidemic of cholera, details of which are reserved for a future report.

JAPAN.

Cholera is no stranger in Japan, which being a maritime country is extremely liable to importations of the disease. In former years epidemics in Japan on a large scale were frequent. In 1895 it may be remembered that no fewer than 55,144 attacks and 40,154 deaths were officially reported in that Empire; and going back as far as 1886, an epidemic comprised no fewer than 155,923 cases and 108,405 deaths. But with increased care in matters of sanitation, Japan has attained a more healthy state of affairs, and outbreaks in recent years have been of comparatively small dimensions. The disease was reported as having occurred in Japan in 1896, 1897, 1898, 1899, 1900, and 1901, in each year in small amount. For example, in 1898 a considerable number of localities were invaded, but the total attacks were less than 100 and were distributed over 11 districts or towns. In 1899 cholera was reported in, at least, six localities, but the total recorded attacks barely reached 50. During 1900 sporadic, probably imported, cases came under observation at Osaka, Yokohama, and Nagasaki. In August a localised outbreak, involving 40 fatal cases, occurred in Fuoka Ken. In 1901 a few cases of cholera were reported between May and September—eight of them from Yokohama, one from Onsen, and five from Formosa.

Japan in 1902, like many other eastern countries, suffered somewhat severely from epidemic cholera, but details of this are reserved for a subsequent report.

TASMANIA.

From a report published in the *Bulletin Quarantinaire d'Egypt* for July 26th, 1900, it appears that a case of Asiatic cholera occurred in Hobart during the week ending June 16th. No details, however, were given of the case or of its source.

RUSSIA.

In October, 1900, a report from Vladivostock stated that cholera had appeared at Novolievsk, and that attacks of a choleraic character had occurred in Santschun, in Manchuria. But no further details were given.

ARABIA.

In 1897 a ship from Muscat brought some pilgrims to Cameran, where one of them died from cholera. No information is, however, forthcoming as to the presence of the disease in Muscat at that time.

During 1898 no record of cholera outbreaks in Arabia are to hand, but in 1899 the disease became somewhat widely prevalent. In September cholera was brought to Matrah, a town of about 20,000 inhabitants, three miles from Muscat, by means, it is said, of travellers from Gwadur, a small town on the coast of Baluchistan. No details of the number of cases comprised in the outbreak are available, but the American Vice-Consul, reporting to his Government, stated that between 25th September and 11th October 135 deaths were assigned to cholera. From Matrah cholera spread to other localities, including Muscat town and the villages of Serar and Kajai in the interior. At Tirvi 300 fatal cases occurred. The town of Sil on the coast suffered in less degree, but the towns of Nokal, Ristag, and Semed in the interior suffered more severely.

Cholera at the end of 1899 had spread over the whole of Oman, and had attacked, it is said, as many as 70,000 persons. While the disease was spreading in Oman, the Bedouin tribes in the vicinity of Bassorah became infected and the malady was widely diffused among the nomadic Arabs about Bagdad, Chotra, Amara, Hai, and Fao. The whole district in the basin of the Euphrates and Tigris became invaded by cholera in the latter part of 1899. At Djevadir, on the shores of the Persian Gulf, 380 cholera deaths had occurred up to the beginning of November. At this time it was believed that Persia along the northern coast of the gulf was also infected by the malady. While cholera was developing in the port of

Bassorah in October 1899, a fatal case occurred on board H.M.S. *Lapwing*, then lying off the town. The patient, a Seedy boy, had been ashore the day before he was attacked.

In the early months of 1900 cholera continued to prevail in the Sultanate of Oman, and along the whole South Arabian coast from Handramant as far as Aden, and also along the caravan routes of Sohar and El Dreun, and up to Abu Dhabi on the Persian Gulf.

During 1901 no official intimation of the presence of cholera in Arabia was received, but early in March, 1902, a very severe epidemic burst out in the Hedjaz, the details of which will be given in a later report.

SYRIA.

In September, 1900, cholera was reported to have broken out at Marask, in the Vilayet of Aleppo, but no details as to the outbreak have been received.

EGYPT.

The s.s. *Queen Alexandra*, for New York, left Calcutta on November 22nd, 1901, and on December 14th reached Suez, where the master reported that one of the crew who became ill on November 26th with acute diarrhœa had died on November 28th. A stoker also had diarrhœa, but recovered. Another stoker became ill on November 29th with choleraic diarrhœa, but he also recovered. The quarantine officials at Suez regarded the ship as "suspected" of cholera, and sent her to Moses Wells to be disinfected. There was no further development of suspicious illness in connection with this ship. Cholera became epidemic in Egypt during 1902.

ENGLAND.

During the period which has elapsed since cholera subsided in Europe in 1895 occasional instances have arisen of ships arriving in ports of England and Wales actually or technically infected by cholera. The following are examples :—At the end of December, 1896, the transport *Nubia* arrived at Plymouth from Calcutta and Colombo with troops among whom cholera had broken out during the voyage. There had been four deaths. Some cases not quite recovered were removed from the *Nubia* to the floating hospital belonging to the Plymouth Port Authority. All the necessary measures were carried out by the officers of the Port Sanitary Authority and the War Office, after conference with Dr. Bulstrode who had been despatched by the Board to await the arrival of the *Nubia*, news of the cholera outbreak on board the vessel having been telegraphed to this country. No extension to shore of the disease took place.

On July 27th, 1900, the s.s. *Borneo* arrived at Plymouth from Calcutta, having called at Colombo, Suez, and Port Said. The master reported that on June 14th and 17th, while loading in Calcutta docks, cholera attacked two members of the native crew, and they were removed to the hospital on shore. On June 19th the ship sailed, and on June 23rd and 28th other two cholera cases occurred, both fatal, the bodies being buried at sea. A fifth attack occurred on board and died on July 15th, but the post-mortem examination left the diagnosis uncertain; this body was also buried at sea, and the cause of death was entered in the log book under the suggestive heading of "suppression of urine." On arrival at Plymouth the crew were medically inspected, and no suspicious illness was found among them. Having landed eight passengers, whose names and addresses were forwarded to the sanitary authorities at their respective destinations, the *Borneo* sailed for the Thames, where she arrived on July 28th, and was dealt with in the usual way by the London Port Sanitary Authority. There was no further manifestation of the disease in connection with this ship.

APPENDIX B.

No. 1.

REPORT on the NATURE of HAFFKINE'S PLAGUE PROPHYLACTIC; by Dr. E. KLEIN, F.R.S.

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On the Nature of Haffkine's Plague Prophylactic; by Dr. Klein, F.R.S.

Since the appearance of epidemic plague at Bombay in 1896 Dr. Haffkine has employed on a considerable scale as a protective inoculation the sterilised broth culture of virulent plague bacilli, which is now known as Haffkine's plague prophylactic fluid. From time to time since 1898 reports have been published from the Bombay Laboratory and from different localities in India giving an account and statistical tables of the results of the prophylactic injection of the fluid by Haffkine, his assistants, and different medical officers. From these reports it appears that as to the real prophylactic value of these injections there can be no manner of doubt. The Indian Plague Commission in 1900–1901 critically sifted the evidence brought before them by Haffkine and by many other medical officers, and, although some of the statistics produced were not admitted by them to be satisfactorily collected and did not conclusively prove in the particular instances the value claimed for the injections, there nevertheless were available statistics from a number of places, such as jails and hospitals, which in the opinion of the Commissioners fully established the value of a prophylactic injection of the Haffkine fluid.

Haffkine himself admitted that owing to the stress of circumstances (the demand for the fluid in India alone was, owing to the spread of the plague, enormous) a great many points concerning the precise nature and the best method of employment of the fluid remained still unsolved. For instance, the Plague Commissioners justly point out that, from the evidence brought before them, there does not seem to be any advantage in reinjection of the same individual, provided the dose in the first instance has produced the anticipated physiological action. Further, as the Commissioners justly observe, there is as yet a great deal of uncertainty as to the dosage for each injection. Haffkine states, provisionally, that the dose for a human being should be such as to cause, a few hours after subcutaneous injection, a rise of temperature of at least 2–3 degrees Centigrade. But the determination of the dose on these lines would on *a priori* grounds meet with great difficulties, because it can hardly be supposed that all human beings injected with the same amount would re-act in the same manner. Another method—also provisional—adopted by Haffkine in judging the dose of the prophylactic is the amount of solid matter (bacterial growth) present in the culture. But this method is evidently beset with quite as great difficulties, for, even assuming that simple inspection could approximately determine the relative amount of growth in different brews, there

must, owing to the bacterial growth being largely in the form of granules and flocculi, be great uncertainty in any attempt to distribute this solid matter in an uniform manner during the customary decantation of the fluid into the several small bottles or tubes ready for use.

Of not less importance, and of equal uncertainty, is the action of the different constituents of the prophylactic, *e.g.*, the bacterial bodies, and the fluid in which they are suspended. The Plague Commissioners, for instance, cannot satisfy themselves as to the presence in the fluid, *per se*, of any toxin or of any bacterial products necessary for the object of prophylaxis.

A further point which unquestionably must be assumed to be of importance is the quality of the strain of the plague bacilli used in establishing a culture. On grounds of analogy, *e.g.*, vibrio choleræ, bac. of typhoid, it is to be anticipated that the initial virulence of the microbe determines, *caeteris paribus*, the degree of protective potency of the ensuing culture. And as a last point worthy of consideration, there is the question of the nature of the change in the blood and tissues of a human being or of an animal injected with the prophylactic; that is to say, the question of the degree of immunity conferred by inoculation against infection, and to what extent are agglutinating, antitoxic, and germicidal substances to be met with in the blood of the injected animal.

All the points above enumerated require to be elucidated before claim can be made to a fair understanding of the action of the prophylactic; before, that is, a rule of thumb practice can be superseded by a scientifically proved method of standardizing and of using the prophylactic.

I now proceed to describe the experiments and observations which have been undertaken towards the elucidation of some of these matters.

The Preparation of Haffkine's Plague Prophylactic.

The fluid which Haffkine (Proceedings, Royal Society, June, 1900) prepares for distribution and transmission is a broth culture of B. pestis incubated for four to six weeks, and then sterilized at 65–70° C. for one hour. It is next decanted into and preserved in special bottles each containing about 0·5 per cent. carbolic acid. The prophylactic employed in the experiments to be recorded was in most respects prepared like Haffkine's broth culture, with addition, that is, of a few drops of sterile clarified butter. It was decanted into test tubes, each capable of containing 32–36 cc., which were then sealed and finally sterilised at 70° C. for one hour. No preservative, however, was added.

Haffkine has pointed out that different "brews" of the prophylactic started from the same plague culture, notwithstanding that the broth itself, the addition of clarified butter, the temperature, and all other conditions are as far as possible the same, show after a like period of incubation different amounts of bacterial growth in the form of floccular and granular sediment. My experience

fully bears this out. Thus of a group of flasks (8–12) treated seemingly, and, indeed, intentionally, in exactly the same manner —*i.e.*, same make of peptone broth, same amount of ghee added, same stock culture of plague used for infection, same platinum needle used in this process, same temperature of incubation, same duration of incubation—not all show the same amount of sediment of solid growth. While some flasks of this brew contain a comparatively large amount of the floccular and granular sediment, others show this to a conspicuously less degree. I have found that, *caeteris paribus*, the incubation of the flasks at 25° C. for the last fortnight or three weeks of preparation—the first fortnight having been passed by the flasks in an incubator at 37° C.—yields the greatest amount of sediment, certainly greater than if the flasks are kept for the whole five week at 37° C.

Another point in which I fully confirm Haffkine's statement, and one which I think of importance, is this: The presence of a thin layer of droplets of ghee on the surface of the broth is an excellent and sure means of increasing the amount of bacterial growth. This is particularly well shown after the inoculated flasks are transferred to a temperature of 25° C. The ghee drops at this temperature become solid flat platelets; and in connexion with them, and extending underneath them rapidly, the growth appears in the form of a whitish scum (with stalactites), which, on shaking, becomes readily detached and falls to the bottom of the fluid, only to be in the course of a few days replaced by a similar fresh scum. In this way, viz., by keeping the flasks for the last two to three weeks at the temperature of 25° C. and shaking the flasks every three or four days, the greatest amount of sediment (granules and flocculi of growth) will be obtained. It is a fact, although it does not well agree with a general assumption, that not even after four weeks is the growth finished, *i.e.*, is the nutritive material in broth exhausted. This may appear strange, since in the case of a rapidly growing microbe like the Bacillus pestis one would *a priori* expect that at a temperature of 37° C. the growth would have been completed and the broth "exhausted" in the space of 10 days or a fortnight. But this is manifestly not the case; after a fortnight's incubation at 37° C. the flasks, on transference to a temperature of 25° C., exhibit a conspicuous further growth which continues even to the end of six weeks. In regard of all flasks so treated, subcultures were made on gelatine and agar with a platinum loop, a single loopfull being transferred from the flask to the new culture medium. In every instance great numbers of colonies developed, particularly in the gelatine tubes. This proves that the bacilli in the flasks were still living and active; that they had not, as was to be anticipated, died off in the course of a few weeks in large numbers. I think, with Haffkine, that the addition of the clarified butter is the important means by which the bacillary growth is maintained and its amount increased.

In the course of the last two years I have sealed and sterilized nearly 12,000 tubes (each containing 32–36 cc.) without a single failure. All of them showed, when kept in an upright position, a perfectly clear fluid with the granular and floccular sediment. Accidental and extraneous contamination did not occur.

The Physiological Action of Solid Sterilized Masses of Plague Bacilli.

All observers who, as regards plague, have worked with the bacillary growth *en masse* have found that the injection into the animal body of the sterilized material in sufficient amounts has a protective action. Haffkine himself (*cf.* the evidence before the Plague Commission) laid stress on this. It is, in his view, the amount of the bacillus sediment in the prophylactic fluid which determines the dose, the amount of precipitate and the amount of the dose standing in inverse proportion. Calmette (Harben Lectures, London, 1900) also relies almost entirely on the bacillary bodies (sterilized) as being the essence of the prophylactic material.

In my Plague Report for 1896 (Report of the Medical Officer for 1896–1897) I had already described (p. 297) a number of experiments in which the bodies of plague bacilli, scraped from the agar surface and sterilized by heat, were injected in repeated doses subcutaneously and intraperitoneally into guinea-pigs and rabbits. I there showed that sterilized cultures (solid growth on gelatine and agar broth cultures) repeatedly injected, in large doses, subcutaneously or intraperitoneally, into guinea-pigs, do not confer absolute protection on the guinea-pigs against further infection any more than does repeated injection of sub-fatal doses of living plague bacilli. In fact, I showed in an unmistakeable manner that the guinea-pig is an animal which it is extremely difficult to immunise against plague. This fact was subsequently verified in a series of experiments which Professor Haffkine and I together carried out in my laboratory with his plague prophylactic. We found that even by injection of enormous doses of Haffkine's plague prophylactic, such as yielded positive results in protection of rats, did not confer absolute protection on the guinea-pigs against subsequent infection.

In the same report, I have also described experiments which conclusively show that, as was to be anticipated from the above negative results, the blood of guinea-pigs which had recovered from induced plague (produced by injection of sub-fatal doses of living plague bacilli) is wholly devoid of immunising or germicidal substances. I have during this year's experiments sought to ascertain whether the blood of guinea-pigs previously prepared, either by repeated injection of sub-fatal doses of living cultures or by repeated injection of large doses of sterile cultures, possesses any agglutinating action on emulsion of plague bacilli; and it is these experiments which I propose here to describe.

It is now well established that by repeated injections of an animal with a particular microbe the blood and tissues of this prepared animal undergo certain changes the result of which is the development in them of various new substances. Amongst these, two at any rate have been studied carefully: (*a*) agglutinins; and (*b*) lysins, or germicidal or immunising substances. I do not discuss here, the matter being outside this report, the different theories that have been put forward as to the probable

nature of these substances, viz., whether they are ferments (Roux *v.* Emmerich) or are some highly and complexly constituted organic bodies other than ferments (R. Pfeiffer, Ehrlich, and others). I am content to give consideration to their mode of action as observed in actual experiment.

(*a*) *The agglutinins.* Bordet and Gruber were the first to show that the blood and blood serum of an animal subjected to repeated injections of culture of the cholera vibrio sooner or later (usually in about a fortnight) acquire a new property: That when a small quantity of either is added to an emulsion of the cholera vibrio the vibrios soon loose their motility, are attracted together, and become at the same time "agglutinated" or "clumped," so as to form smaller or larger masses. These, on account of their weight, gradually sink to the bottom of the tube in which the emulsion is contained, and the previously turbid fluid thus becomes clear. This process of "clumping" or "agglutinating" has been also studied in other cases besides those of the cholera vibrio, and it has been shown that the phenomenon is of a fairly general character; that the blood of an animal which has been repeatedly injected with a given microbe—pathogenic or non-pathogenic—acquires the power to "agglutinate" an emulsion of the particular microbe with which it had been, so to speak, "prepared." It had been further shown that the degree to which the agglutinating power of the blood can be raised differs, *caeteris paribus*, in the different animals for the different microbes; that it differs also in regard to diverse methods of administration, and again as to the time at which the agglutinating power makes its appearance. A few instances may be mentioned in illustration: After intraperitoneal injection into guinea-pigs of sub-fatal doses of living culture of cholera vibrio, the blood serum of the animal shows some weeks later (two to three) distinct agglutinating power with an emulsion of cholera vibrios in the proportion of 1 : 20 or even 1 : 40. By repeated (three) intraperitoneal injection of culture of living cholera vibrios this agglutinating power of the blood serum may be raised to 1 : 100 or even 200. I have, like other persons, obtained a high degree of agglutinating action by injecting subcutaneously first a large dose of sterilized and then, from week to week, gradually increasing doses of living cholera culture. A fortnight after the last (fifth) injection the blood serum of the guinea-pig possessed so strong an agglutinating power that one part of the serum agglutinated completely, and within 10 minutes, 200 parts of bouillon emulsion of living (recent) agar culture, or, better still, a 24 hours' old peptone salt solution culture of the vibrio.

As regards the typhoid bacillus, a high agglutinating action of the blood serum of guinea-pigs can be produced in just the same way. After a fifth injection the blood serum agglutinates completely in the proportion of 1 in 400 within 10 minutes, the bouillon emulsion of the typhoid bacillus being made from a 48 to 72 hours old gelatine culture.

There is, however, a difference between the two microbes, the vibrio of cholera and Bacillus typhosus, as regards the above reaction. The agglutinating action of the blood serum of a cholera

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prepared animal does not ensue immediately, say within a few days, but takes some time, at least a fortnight, to develop; whereas in the case of a typhoid prepared guinea-pig the agglutinating action can be shown to have set in within a few days of the injection, though of course it increases somewhat as time passes. This fact was first noted in the case of typhoid fever in man by Widal. He found that the blood serum possesses early in the acute stage of the illness an agglutinating action, and that the fact therefore is of great value for diagnosis. As regards cholera in man, on the other hand, it has been shown that the agglutinating action of the blood cannot be demonstrated till about two or three weeks after the disease has passed off.

I now proceed to consider how and to what extent the blood of animals previously "prepared" with plague culture acquires agglutinating action.

Experiments in Agglutination with Culture of Bacillus Pestis.

Various observers—Paltauf (Wiener Kl. Wochenschrift 1897 N. 22); German Plague Commission (Arbeiten aus dem Kaiserl. Gesundh. Band. XVI.); Russian Plague Commission (Annales de l'Institut Pasteur 1897 N. 7); Vagedes (Arb. des K. Gesundh. Band. XVII.)—have described positive results on plague culture with the blood of persons that had passed through and become convalescent for some weeks from an attack of bubonic plague. Similar positive results have been noted with the blood of animals that had previously been prepared and protected by injection of non-fatal doses of plague culture, or by injection of Haffkine's prophylactic. Thus Leumann, in various reports from the Bombay Plague Laboratory, mentions such positive agglutination results; Zabolotny* likewise describes such positive results; Dr. Markl† and others have stated the same. But there is no unanimity of these observers, either as to the degree of dilution or as to the time in which the addition of the blood serum produced the agglutination; there is in most of their descriptions merely the statement that positive results were obtained. Further, there is no detailed account of the manner in which the test was applied. As I have pointed out in the *Lancet* (February 16th, 1901), it is extremely difficult to obtain an emulsion of plague culture suitable for the agglutination test, owing to the fact that the Bacillus pestis has in all media a tendency to grow in coherent masses, the individual bacilli becoming naturally agglutinated by an interstitial (intercellular) sticky substance. As is well known, and as I have pointed out in my report for 1896, the B. pestis forms in broth cultures granules and flocculi of agglutinated masses, which, even on shaking, do not readily or to any large extent break up into their constituent elements. Wherefore a broth culture cannot be used for the test since the plague bacilli are already showing agglutinated masses. The same is the case with agar cultures. As is known, and as has been repeatedly pointed out

* Archives des Sciences Biologiques de St. Petersbourg, Vol. VIII., N. 1.

† Centralbl. fur Bakteriologie, &c., Vol. XXIX., No. 21, p. 810.

(1896), the Bacillus pestis grows on the surface of agar as a characteristic filmy translucent sticky layer; so that when, with a platinum needle, a particle is attempted to be removed the growth is drawn out along with it as a slimy thread. When an attempt is made to emulsify such growth the utmost that can be achieved by shaking it up in broth or salt solution is a breaking up into larger or smaller flocculi, on account of the presence of the gelatinous interstitial substance by which the bacterial cells are agglutinated. To use therefore for the agglutination test an emulsion in which from the outset there are present small and large masses would not only be useless but might be altogether misleading. While these difficulties are found with broth cultures and with cultures on agar and on serum, they apply in much less degree to cultures of B. pestis on the surface of gelatine. For on this medium the Bacillus pestis forms a growth which is fairly dry and not of a viscid nature, although here also the bacilli are intimately aggregated. A fairly uniform emulsion can, however, usually be obtained from a surface gelatine culture by shaking up a particle of the growth in bouillon or in salt solution. By shaking up gelatine growth in distilled water an excellent emulsion can also be rapidly established.

First as to the bouillon and salt emulsion of gelatine culture of the bacillus.

After a considerable amount of experimentation with gelatine cultures, recent and old, I have found that gelatine cultures of a recent or fairly recent date, *e.g.*, established from 2 to 10 or 12 days, are most suitable. A particle of the growth is removed with a platinum needle or platinum loop and distributed by agitation in, say, salt solution so as to render the fluid slightly turbid. As in other similar experiments on agglutination, too great turbidity, *i.e.*, too thick an emulsion, is to be avoided. While in most instances an emulsion is obtainable in this manner, in others it is not possible to get rid of small aggregations of the bacilli. No amount of shaking can dissociate these, and such an emulsion is for obvious reasons not of sufficient reliability for application of the agglutination test. When such is the case I adopt the following plan for making a workable emulsion: I make (*a*) a thick emulsion and filter this through a double filter paper, by which means all the larger aggregations are kept back and only the isolated or fairly isolated or very minute groups are let through; Or, (*b*), I take a particle of growth from the gelatine culture tube and rub it over the slanting surface of a fresh gelatine tube, after which a few cc. of salt solution are poured over this new surface and the tube slightly shaken till the fluid had worked off the matter from the surface.

I have made also an extensive series of observations with regard to the mere *sedimentation* of emulsions (broth, salt solution, water) of B. pestis in tubes, in capillary pipettes, &c. As a result I have found that any conclusion as to positive sedimentation and agglutination resulting from addition to them of blood has no value whatever, and for the simple reason that some (in fact many) emulsions of plague bacilli sediment in such tubes and

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capillary pipettes spontaneously without the addition of anything Similarly, they sediment after the addition of various indifferent fluids, *e.g.*, normal blood serum, aqueous humour, strong salt solution, peptone solution. All these cause the bacilli to settle down to the bottom of the fluid which itself becomes quite limpid. I would go so far as to warn all observers from relying on the agglutination test with emulsions of non-motile bacteria in which is involved similar liability to mere sedimentation. At any rate my experiments on agglutination with emulsion of B. pestis by sedimentation have given very unsatisfactory results, and I have therefore abandoned them and have relied solely on *the agglutination test under the microscope.* In using this it is necessary to subject a large drop of the mixture of emulsion and blood serum to microscopic examination, so as to give the suspended bacilli a fair chance of coming together. If the test be made by covering a small drop of the mixture deposited on a glass slide with a covering glass, and thereby exposing the bacilli only in a very thin layer, there would be no chance given to the non-motile (plague or other) bacilli, if any were present, to respond to the agglutination force.

A further point in connexion with these experiments which needs to be insisted on, is that the agglutination test is valueless with bouillon emulsions. If a good and workable bouillon emulsion of B. pestis is prepared from a gelatine culture in the manner already described—an emulsion for instance in which the great majority of the bacilli are well isolated and in which perhaps only here and there small groups of two or three bacilli occur—if, I say, such bouillon emulsion is then watched under the microscope it will be found that agglutination occurs in a comparatively rapid way. Clumps of fair size are formed within 10–15 minutes or even less, so much so that in some experiments with no addition of any material whatever "complete" agglutination in fairly large masses and disappearance of all single bacilli as such occurs in 15–30 minutes. Bouillon emulsions of plague bacilli for the object of making the agglutination test are therefore altogether useless. More than that: I have shown (*The Lancet*, February 16th, 1901) that the addition of sterile bouillon to a good and otherwise permanent salt emulsion of B. pestis, in the proportion of 1 to 20 or even 1 to 40, causes within 15–30 minutes distinct agglutination. I am disposed to think that the unreliable and unsatisfactory agglutination results obtained by some observers with the B. pestis have been due to their using bouillon emulsions, such for instance as are very useful in the case of B. typhosus, Vibrio choleræ, and other microbes.

Another kind of emulsion to be avoided in testing for agglutination with the plague bacillus is the watery emulsion. The first experiments that I made with a watery emulsion of gelatine plague culture were remarkable and deserve to be described in detail. Removing a particle of the growth from a week's old gelatine culture (slanting surface) and placing it in sterile distilled water, it was noticed that even a comparatively slight agitation produced an excellent emulsion; very soon neither with the unaided eye nor with the microscope could any aggregated mass

be recognised, the bacilli formed indeed a uniform excellent emulsion. The blood serum of an animal which I had previously (and also afterwards) ascertained to possess distinct agglutinating power in dilution of 1 in 20, was added in the same proportion (viz., 1 in 20) to the above watery emulsion of plague bacilli. The result was quite unexpected, inasmuch as there occurred complete and striking agglutination within five minutes. It was, however, noticed that on adding the blood as such (1 part) to an equal amount (20 parts) of water there occurred at once a dis colouration of the fluid (washing out of the Hæmoglobin of the blood corpuscles), in consequence of which the blood became laky and only the discoloured stroma of the blood discs was left. The agglutinated masses of the plague bacilli in the mixture were seen to be especially associated with the discoloured stromata of the blood discs. A comparative experiment made with blood of a normal rabbit (as also with blood of normal guinea-pig, normal rat, and normal man) produced exactly the same result; and I must accordingly attribute to the hæmolysis occurring when a small quantity of blood is placed in a large volume of water this phenomenon of agglutination of the bacilli in watery emulsion of plague culture.

For making, therefore, a trustworthy test experiment as to agglutination of the bacilli of plague by a given sample of blood neither bouillon emulsions nor watery emulsion of plague culture must be used. The test should always be made with a salt solution emulsion prepared as described above. A good salt emulsion in a control microscopic specimen sealed up shows, even after 24 hours, the bacilli in a isolated condition.

Next as to the blood to be tested. Comparative observations which I have made in this respect teach that care is required to add to the emulsion the defibrinated blood or blood serum, not blood in which complete separation of the fibrin has not yet taken place; because in the process of coagulation apparent agglutination of the bacilli through entanglement of them in fibrin threads might easily be mistaken for real agglutination.

Another point that requires elucidation is this: Granted that a proper salt emulsion of plague bacilli is being used, and granted also that the sample of blood to be tested is used after the complete separation of the fibrin, the question arises in what dilution and for what length of time should the test be carried out? As is well known in the case of an animal well "prepared" with typhoid culture, or with cholera culture, agglutination is positive even when the animal's blood serum is used in very high dilutions—*e.g.*, 1 in 200, 1 in 500, and even 1 in 1,000—agglutination (under the microscope) occurring in a decided fashion within the hour.

In the observations of some authors (Bordet) the addition of normal serum, the placing of the mixture in the hot incubator, and various other factors are introduced which have an accelerating influence on the agglutination. These and similar observations are no doubt, both from a theoretical and practical point of view, of value. But in the case of the agglutination of plague culture I have limited myself preferably to making

the test in as simple and uniform a manner as possible, so as to avoid the introduction of quasi extraneous, for the most part unknown, new factors. The explanation of the process and nature of the phenomenon of agglutination is in itself complex and difficult in its most simple form, and it is made considerably more complex, without adding to the better understanding of it, by introducing a number of unknown additional factors. I have convinced myself early in my experiments that the blood serum of rats previously protected against plague, as also the blood serum of guinea-pigs previously prepared by repeated injection of sub-fatal doses of plague culture, has unmistakeably the power to agglutinate the plague bacilli in a salt emulsion of gelatine plague culture when used in dilution of 1 in 20, this agglutination taking place within the half hour.

As will be presently described, the agglutination test has been made in a considerable number of cases of protected animals, and as a result it has been found that a dilution of 1 in 20 left at rest for half to one hour, is a fair standard and index for deciding one way or another. In the first place, I found that if, in a given instance, the agglutination test was positive with a dilution of 1 in 20 within the half hour, it was positive also at 1 in 30 within the hour, but doubtful with 1 in 40 within the hour; and, on the other hand, that if the agglutination test was negative at 1 in 20 within the half hour, it was equally negative at 1 in 10, or less, dilution within the half hour.* In all the statements to be made here the test was declared positive if in dilution of 1 in 20 distinct clumping was observed within the hour in a preparation made in the manner of the hanging drop.

(I.) *EXPERIMENTS OF AGGLUTINATION WITH BLOOD OF GUINEA-PIGS.*

1. *Guinea-pigs* 1 *and* 2.—(*a.*) These two guinea-pigs were injected, February 18th, with a salt emulsion of the laboratory B. pestis,† scraped from the slanting surface of an agar culture. The emulsion was thick and strongly turbid, and had been sterilized at 70° C. for 15 minutes. Cultures made after the sterilization did not yield any colonies of B. pestis. Each animal received, subcutaneously, the whole growth covering the surface of one agar tube (6 centimetres by 2 centimetres).

(*b.*) The same two guinea-pigs were re-injected, subcutaneously, on February 28th (10 days later) with exactly the same kind and same amount of sterilized culture.

On March 11th (*i.e.*, 11 days after the second injection) blood of both guinea-pigs was withdrawn, allowed to clot, and test was made with the serum on salt emulsion of the laboratory B. pestis† from gelatine culture, the dilution being 1 in 20.

* Dr. Markl's observations, Central bl. f. Bakteriologie, &c., p. 810, Vol. XXIX., N. 21, lose a great deal of their value because he uses dilutions as low as 1 : 2, 1 : 5, and speaks of 24 hours' duration.

† In all experiments described here and subsequently the strain of plague bacilli was one derived from a case of plague pneumonia that had occurred in 1896 in the London docks.

[It is to be understood that in all experiments (without exception) of agglutination of emulsion of plague bacilli a control specimen was made of the emulsion alone without the blood, so as to make sure that in the particular emulsion agglutination did not occur spontaneously. Such has taken place in few instances for reasons unknown and undiscovered. In such an instance the experiment with the blood was rejected and repeated on a subsequent day.]

In 10 to 20 minutes there was an indication of the formation of small clumps. In one hour the number and size of the clumps had increased; but altogether the agglutination was slight and not very pronounced.

(*c.*) The same two guinea-pigs were therefore re-inoculated on March 11th with the same amounts and the same kind of sterilized plague culture as in the previous instance.

On March 27th, that is 16 days later, the blood serum of these two guinea-pigs was again tested on salt emulsion of B. pestis (from gelatine culture), dilution 1 in 20. In 30 minutes the agglutination was distinct, some largish clumps having formed, and in one hour it was unmistakeable and practically most bacilli had aggregated into loose masses.

It follows from these experiments that after three subcutaneous injections of guinea-pigs with large masses of solid growth of sterilized plague bacilli the blood of these animals acquired unmistakeably the power to agglutinate plague bacilli.

The blood of one of these guinea-pigs was used for an agglutination experiment on two different strains of plague bacilli, the one derived from a plague rat which died in a dock warehouse in Cardiff, the other from a plague rat which died in Cape Town. In both these instances the test (dilution 1 in 20 for half an hour) proved as positive as with the strain of laboratory plague bacilli.

(*d.*) The same two guinea-pigs were again injected on March 27th with about a platinum loopful of living plague bacilli from an agar surface culture about seven weeks old; that is to say, they were injected with a comparatively small and presumably non-fatal dose of an attenuated culture of living plague bacilli. This was done because former experience (*see* my Report, 1896–1897, p. 287) has shown that it is extremely difficult to render guinea-pigs immune against largish doses of living plague bacilli. As a matter of fact, both the above guinea-pigs developed buboes in the course of the next few days, and one animal (guinea-pig No. 2) was found dead on the 10th day after the last injection. The other animal recovered completely. Nineteen days after the last injection the blood serum of this animal was tested on salt emulsion of B. pestis (dilution 1 : 20), two different strains being used : (*a*) the laboratory strain ; (*b*) a strain derived from a case

of bubonic plague that had occurred in a sailor at Llandaff. The blood serum of the above guinea-pig caused decided agglutination of both strains in 10 minutes, the control specimen of the salt emulsion showing no alteration.

The single injection, therefore, of living culture had decidedly enhanced the agglutinating power of the blood serum of this animal.

(*e*.) The further history of this animal is as follows :—On April 22nd it was re-inoculated subcutaneously with one loopfull of living bacilli taken from a recent gelatine culture ; it was further injected on May 2nd and May 28th and June 17th, each time with two to three loops of living gelatine culture. On July 9th its blood serum was tested (dilution 1 : 20), and found to produce complete agglutination in about five minutes, certainly within 10 minutes. On same day (July 9th) it was again injected with two to three loops of living culture. Its blood serum was tested (dilution 1 : 20) on July 16th and gave complete agglutination of plague emulsion in 10 minutes.

On July 18th guinea-pig No. 1 was further injected with two to three loops of living culture. On July 29th its blood serum was tested (dilution 1 : 20) ; result, no agglutination in 15 minutes, but distinct in 40 minutes. It was again injected on July 31st. On August 9th its blood serum produced no agglutination in 30 minutes. The animal was re-injected on August 26th. Its blood serum was tested on the 10th of September ; no agglutination in 30 minutes. Re-injected on September 16th. Blood serum showed no agglutination on October 1st, but gave distinct and complete agglutination within 10 minutes on October 15th and on October 17th.

It will be seen from this experiment that the agglutinating power of the blood serum of this animal (No. 1) showed a gradual increase in degree as time went on, corresponding to the increasing number of injections, but that this proceeded only to a certain point. After a while further injection not only did not enhance this power, but failed to maintain it ; though still later the power became (after additional injection) again restored. These results, *quâ* plague, are quite in harmony with those already obtained in regard of parallel experiments as to agglutinins (with typhoid bacillus, cholera vibrio, and bacillus coli) ; and as regards also anti-toxins with the microbes of diphtheria and tetanus. As in former experiments (1896–1897) with plague, so now, even a sixth injection was followed by the appearance of a bubo, though the animal remained otherwise lively and fed well.

This guinea-pig No. 1 will be again referred to at a later stage of this report.

2. *Guinea-pigs Nos.* 3 *and* 4.—These two animals were subjected to repeated injections with at first sterile, later with living culture, of B. pestis ; but the experiment differs from the previous

experiment in that all injections were made intraperitoneally. Procedure was as follows:—

No.	Date of Injection.	Method of Injection.	Material (and amount) Injected.
1st	May 6th ..	Intraperitoneal ..	The whole growth scraped from the surface of gelatine culture and sterilized for 15 minutes at 70° C.
2nd	" 22nd ..	" ..	" " "
3rd	June 5th ..	" ..	" " "
4th	" 14th ..	" ..	Small dose of living culture (gelatine).
5th	July 9th ..	" ..	" " "
6th	" 18th ..	" ..	" " "
7th	" 31st ..	" ..	" " "
8th	August 27th ..	" ..	" " "
9th	September 16th ..	" ..	" " "

The blood serum was tested (dilution 1 : 20) on the following dates, and with the following results in one hour:—

No.	Date.	Result.
1st	June 4th	Negative.
2nd	" 13th	"
3rd	" 26th	Positive (?).
4th	July 9th	Rapid agglutination within 10 minutes.
5th	" 29th	Distinct clumping in 10 minutes.
6th	August 9th	Complete agglutination in 10 minutes.
7th	September 12th	Positive in 5 minutes.
8th	October 1st	Indication of agglutination in 10 minutes, but not better in 30 minutes nor in 1 hour.

It is seen from this series that the triple intraperitoneal injection of sterile culture was less effective as to the production of agglutinins than had been subcutaneous injection of like material; that the subsequent two intraperitoneal injections of small doses of living culture brought about distinct presence in the blood of agglutinins; and that while further similar injections continued to enhance the agglutinating power of the blood, the ninth injection was followed by a distinct decrease of this power.

3. *Guinea-pigs Nos.* 5 *and* 6.—These two animals (half-grown) were repeatedly injected subcutaneously with *Haffkine prophylactic*, prepared by myself in the manner already described.

The animals were injected on the following dates, and with the following amounts :—

No.	Date of Injection.	Method of Injection.	Material (and amount) Injected.
1st	June 27th ..	Subcutaneous ..	10 cc. of Haffkine's prophylactic
2nd	July 3rd ..	" ..	5 " " "
3rd	" 18th ..	" ..	10 " " "
4th	August 1st ..	" ..	10 " " "
5th	" 29th ..	" ..	10 " " "
6th	September 17th ..	" ..	10 " " "
7th	October 21st ..	" ..	10 " " "

The blood serum was tested (dilution 1 in 20) on the following dates, and with the following results :—

No.	Date.	Result.
1st	July 8th	Agglutination doubtful in one hour.
2nd	" 15th	Negative in one hour.
3rd	" 30th	" " " "
4th	August 28th	" " " "
5th	September 13th	" " " "
6th	November 19th	" " " "

The subcutaneous administration, many times repeated, of Haffkine's prophylactic had therefore no result in producing agglutinin such as was demonstrable after repeated injection of small doses of living culture.

4. *Guinea-pigs Nos. 7 and* 8.—These, which were half-grown, were injected intraperitoneally on the following dates, and with the following results :—

No.	Date of Injection.	Method of Injection.	Material (and amount) Injected.
1st	June 17th ..	Intraperitoneal ..	5 cc. of Haffkine's prophylactic.
2nd	" 27th ..	" ..	5 " " "
3rd	July 11th ..	" ..	5 " " "
4th	" 18th ..	" ..	5 " " "
5th	August 1st ..	" ..	5 " " "
6th	" 29th ..	" ..	6 " " "
7th	September 17th ..	" ..	10 " " "
8th	October 21st ..	" ..	10 " " "

The blood serum was tested (dilution 1 in 20) on the following dates, with the following results :—

No.	Date.	Result.
1st	June 27th	Indication of agglutination in 15 minutes.
2nd	July 8th	Complete clumping in 10 minutes.
3rd	„ 30th	Slight clumping in 20 minutes.
4th	August 8th	Negative in 1 hour.
5th	September 9th	„ „
6th	November 19th	„ „

This series of experiments are in accord with those in which the blood after repeated injections acquired a gradually increasing agglutinating power, and later on, notwithstanding continued injection, again lost it. They moreover tend to show that the intraperitoneal injection of small doses of Haffkine's prophylactic into guinea-pigs is more conducive to the formation of agglutinin than the subcutaneous administration of doses twice as large.

(II.) *EXPERIMENTS OF AGGLUTINATION WITH BLOOD OF RABBITS.*

In this series rabbits were substituted for guinea-pigs, and, as will be shown, the rabbit proved very much more satisfactory.

5. One half-grown rabbit, No. 1, was injected *intravenously* (ear vein) repeatedly with at first sterile and then living plague culture.

No.	Date of Injection.	Method of Injection.	Material (and amount) Injected.
1st	May 6th	Intravenous ..	Salt emulsion of plague growth scraped from the surface of a gelatine culture and sterilized for 15 minutes at 70° C. The amount used for each animal was about ⅓ of a culture (6 centimetres by 2 centimetres).
2nd	„ 28th	„ ..	Same amount and same kind of material.
3rd	June 13th	„ ..	„ „ „ „
4th	July 9th	„ ..	Small amount of emulsion of living culture.
5th	„ 18th	„ ..	„ „ „ „

This rabbit was found dead on July 20th. On post-mortem examination the spleen was seen to be permeated by small grey

nodules, which on microscopic and cultural examination proved to be of the nature of pseudotubercle. No plague bacilli were demonstrable either in the blood or the organs.

The blood of the rabbit was, however, tested for its agglutination (dilution 1 : 20) on various occasions, with the following interesting results :—

No.	Date.	Result.
1st	May 24th	Negative.
2nd	June 5th	Distinct agglutination in 30 minutes.
3rd	July 7th	Complete agglutination in 10 minutes.
4th	" 16th	" " within 5 minutes.

From this it appears that after the first intravenous injection of sterile culture no agglutinin had yet been formed, but that after the second such injection there was, eight days later, distinct agglutinin present. Further, that this became enhanced by a similar third injection, and was still more distinct after a fourth injection with living culture.

6. One half-grown rabbit, No. 2, was injected into the ear vein in precisely the same manner and at the same time as the rabbit of the previous experiment. A fortnight after the third injection with sterile culture (first injection May 6th, second injection May 28th, third injection June 13th), *i.e.*, June 27th, the animal's blood serum was tested (dilution 1 : 20) and was found to produce complete agglutination in 10 minutes; the same result as was observed in the previous experiment. The animal unfortunately was found dead on July 8th. The post-mortem examination showed extensive cysticercus disease of the omentum.

7. A half-grown *rabbit, No.* 3, was injected *subcutaneously* with Haffkine's prophylactic at the following times :—

No.	Date of Injection.	Method of Injection.	Material (and amount) Injected.
1st	June 17th ..	Subcutaneous ..	10 cc. of Haffkine's prophylactic.
2nd	July 3rd ..	" ..	10 " " "
3rd	" 18th ..	" ..	10 " " "
4th	August 1st ..	" ..	10 " " "
5th	" 29th ..	" ..	10 " " "
6th	September 17th ..	" ..	10 " " "
7th	October 21st ..	" ..	20 " " "
8th	November 21st ..	" ..	20 " " "

The results of the testing of this rabbit's blood serum on emulsion of B. pestis (dilution 1 : 20) were the following :—

No.	Date.	Result.
1st	June 27th	Negative in 1 hour.
2nd	July 2nd	" "
3rd	" 8th	" "
4th	" 31st	" "
5th	August 26th	Positive in 10 minutes.
6th	September 13th	Negative in 1 hour.
7th	October 2nd	" "
8th	" 15th	" "
9th	January 16th	Positive and distinct in 15 minutes

This experiment in its early stages contrasts markedly with similar stages of experiment 5; for it shows that the *subcutaneous* injection of Haffkine's prophylactic, even after repeated (three) administration of considerable amounts (10 cc. each time) did not succeed in producing agglutinin in the animal's blood.

8. *Rabbits Nos.* 5 *and* 6.—In this experiment the administration of Haffkine's prophylactic was effected in two rabbits by *intravenous* followed by *subcutaneous* injection. As regards rabbit No. 5 :—

No.	Date of Injection.	Method of Injection.	Material (and amount) Injected.
1st	July 1st ..	Intravenous ..	5 cc. of Haffkine's prophylactic.
2nd	" 11th ..	" ..	5 " " "
3rd	" 18th ..	Subcutaneous ..	10 " " "
4th	August 1st ..	" ..	10 " " "
5th	" 29th ..	" ..	10 " " "
6th	September 17th ..	" ..	10 " " "
7th	October 21st ..	" ..	20 " " "

The animal died on November 4th. On post-mortem examination the liver was found atrophied, fatty; the stomach was much distended showing few hæmorrhagic patches in the serous covering; in the abdominal cavity were numerous cysticerci.

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The blood serum of this animal (rabbit No. 5) had been tested for agglutination on the following dates, and with the following results:—

No.	Date.		Result.
1st	July	8th	Negative.
2nd	"	16th	Complete agglutination in 15 minutes.
3rd	"	31st	Negative in 1 hour.
4th	August	26th	Positive in 10 minutes.
5th	September	9th	Negative in 1 hour.

As to rabbit No. 6:—

No.	Date of Injection.		Method of Injection.	Material (and amount) Injected.
1st	July	1st ..	Intravenous ..	5 cc. of Haffkine's prophylactic.
2nd	"	11th ..	" ..	5 " " "
3rd	"	18th ..	Subcutaneous ..	10 " " "
4th	August	1st ..	" ..	10 " " "
5th	"	29th ..	" ..	10 " " "
6th	September	17th ..	" ..	10 " " "
7th	October	21st ..	" ..	18 " " "
8th	November	21st ..	" ..	20 " " "

The blood serum of this animal was tested, dilution 1 in 20.

No.	Date.		Result.
1st	July	16th	Positive in 20 minutes.
2nd	"	31st	Negative in 1 hour.
3rd	November	14th	Indication in 15 minutes.
4th	January	1st	Distinct agglutination 10-15 minutes.
5th	"	16th	" " "

This experiment is confirmatory of that with the previous animal, No. 5. A twofold intravenous injection of Haffkine's prophylactic brought about production of agglutinins. But at this stage a single subcutaneous injection of 10 cc. not only did not enhance the agglutinating power, but on the contrary seemed to destroy it, though it reappeared after several further subcutaneous injections. Another important fact is brought to light in this as in experiment No. 7, viz., the distinct agglutination possessed by the blood serum nearly two months after the last injection

I shall have to reconsider later on other points concerning these animals, but at present I proceed with the examination by further experiments of the agglutination phenomenon.

(III.) *EXPERIMENTS IN AGGLUTINATION AFTER INJECTION OF FILTRATE OF HAFFKINE'S PROPHYLACTIC.*

9. In this experiment two half-grown guinea-pigs were injected subcutaneously with the clear *filtrate* of Haffkine's prophylactic. This was obtained by simply opening some of the sealed tubes in which the prophylactic had been preserved, decanting the clear fluid and passing it through a Pasteur Chamberland filter. The filtrate was of course perfectly limpid.

Guinea-pigs Nos. 9 and 10 (half-grown) were injected *subcutaneously*, each receiving 10 cc. of the above filtrate.

No.	Date of Injection.	Method of Injection.	Material (and amount) Injected.
1st	September 10th ..	Subcutaneous ..	10 cc. of the filtrate.
2nd	" 17th ..	" ..	" "
3rd	October 21st ..	" ..	" "

One of these guinea-pigs died December 23rd. The animal was extremely emaciated, but no cause for its death could be found.

The blood serum was tested, dilution 1 in 20.

No.	Date.	Result.
1st	September 29th	Negative.
2nd	October 12th	"
3rd	November 21st	"

10. The half-grown guinea-pigs Nos. 11 and 12 were injected *intraperitoneally*, each receiving 10 cc. of the filtrate.

No.	Date of Injection.	Method of Injection.	Material (and amount) Injected.
1st	September 10th ..	Intraperitoneal ..	10 cc. of the filtrate.
2nd	" 17th ..	" ..	" "
3rd	October 21st ..	" ..	" "

The tests with the blood serum were made as above, but with completely negative result.

11. Two half-grown rabbits, Nos. 7 and 8, were *subcutaneously* injected with the same filtrate, each animal receiving 20 cc.

No.	Date of Injection.	Method of Injection.	Material (and amount) Injected.
1st	September 10th ..	Subcutaneous ..	20 cc. of the filtrate.
2nd	" 17th ..	" ..	" "
3rd	October 21st ..	" ..	" "
4th	November 21st ..	" ..	" "
5th	January 2nd ..	" ..	" "

The blood serum of both animals was tested, dilutions 1 : 20 and 1 : 10 in each instance.

No.	Date.	Result.
1st	October 2nd	Negative.
2nd	November 20th	"
3rd	January 1st	—

From this it appears that neither in the rabbit nor in the guinea-pig was there any agglutinin formed after repeated injection of the *filtrate alone* of Haffkine's prophylactic. It was altogether unexpected that half-grown rabbits should after receiving a total of 100 cc. of this filtrate yield blood serum which showed no sign of agglutinin even in dilution of 1 : 10.

(IV.) *EXPERIMENTS WITH BLOOD SERUM OF RATS.*

I have already mentioned that rats which had passed through the disease (rats which had first been prepared by Haffkine's prophylactic, 10 cc. subcutaneously injected) and were then injected with more than an ordinarily fatal dose of living culture of the plague bacillus developed a distinct bubo which suppurated. This after some days healed completely, and the animals' blood tested along with salt emulsion of gelatine culture showed in a conspicuous degree agglutination (dilutions 1 : 20 and 1 : 40) in 10 minutes. I have had occasion to repeat this experiment on other rats which had passed through a non-fatal attack of plague, and have been able fully to confirm it.

12. In this experiment three rats were injected subcutaneously with Haffkine's prophylactic, each animal receiving 10 cc.

No.	Date of Injection.	Method of Injection.	Material (and amount) Injected.
1st	November 21st ..	Subcutaneous ..	10 cc. of Haffkine's prophylactic.
2nd	December 31st ..	" ..	" " "

As was ascertained, from the experiments carried out in conjunction with Prof. Haffkine in 1899, a single injection of 10 cc. of this prophylactic into rats suffices to give them protection against an otherwise fatal dose of living plague. In the present instance no further injection beyond the above 20 cc. was employed. The blood serum of one of the rats (after the animal had been killed) was tested (dilution 1:20) on January 30th, and it showed no distinct agglutination within one hour.

13. Four rats were injected on December 31st subcutaneously with Haffkine's prophylactic, each animal receiving 8 or 10 cc.; that is to say, two full grown animals received each 10 cc., other two half-grown 8 cc. in each instance.

On February 5th, one of the small animals was killed and its blood serum tested (dilutions 1:20 and 1:10), with negative result in one hour.

It follows from these experiments that injection into rats of Haffkine's prophylactic in amount more than sufficient to protect them against a fatal dose does not cause the production in their blood of any agglutinins.

14. In this experiment three rats were subcutaneously injected with the *filtrate* of Haffkine's prophylactic, each animal receiving 10 cc. on November 21st and other 10 cc. on December 31st.

Their blood serum was tested on February 2nd (dilution 1 : 20 and 1 : 10), with completely negative result. This result was to be expected, considering that the injection of the prophylactic as such did not in previous experiments produce agglutinins.

The results, then, of the numerous experiments here described can be thus summarised :—

1. The blood of rodents (guinea-pigs, rabbits, rats) which have been repeatedly injected with large masses of the *sterilized* bodies of B. pestis possesses the power of agglutinating a duly prepared emulsion of the bacillus pestis. Especially in rabbits is this manifest.

2. The same agglutinating action is observed with respect to the blood of rodents which having been injected with sub-fatal doses of *living* plague bacilli had as a consequence been affected with the disease and recovered from it.

3. The increase in agglutinating action of the blood of these "prepared" animals is not in a direct ratio to the amount of material injected, or to the number of the different injections. It appears to go on increasing up to a certain degree, and then to decrease or be lost entirely.

4. The repeated administration of Haffkine's prophylactic into guinea-pigs, when injected *subcutaneously*, produced no agglutinin in the blood; whereas the repeated *intraperitoneal* injection of the prophylactic into guinea-pigs appears to have produced agglutinin which, however, was soon lost, even during continuance of "treatment."

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5. In the rabbit, on the other hand, the repeated injection (intravenous, less when subcutaneous) of Haffkine's prophylactic did produce agglutinins at one or another stage, although on the whole such production was uncertain.

6. In the rat the repeated injection subcutaneously of Haffkine's prophylactic failed to produce agglutinin.

7. The repeated injection (in whatever way) of the *filtrate* of Haffkine's prophylactic into rodents (guinea-pigs, rabbits, rats) failed to produce agglutinins.

Besides the experiments on agglutinins above summarised, investigation has been made of the power of the blood serum of guinea-pigs and rabbits, and in a few instances also of rats, previously immunised in various ways, in inhibiting the action of the living Bacillus pestis, when such serum along with a lethal dose of plague was injected into a susceptible or unprepared animal. In other words, account having been given of the agglutination or test *in vitro*, what follows will deal with Pfeiffer's test or the test *in corpore.*

(V.) *EXPERIMENTS IN TESTING BLOOD OF PREPARED ANIMALS FOR THE PRESENCE OF GERMICIDAL SUBSTANCE.*

(*a.*) *Guinea-pigs.*—With reference to the guinea-pig of experiment I., guinea-pig No. 1, referred to at page 366, it will be convenient here to restate, in tabular form, the several occasions on which this animal had been injected, and the material used for injection in each instance :—

No.	Date of Injection.	Method of Injection.	Material Injected.
1st	February 18th ..	Subcutaneous ..	Sterile agar culture.
2nd	" 24th ..	" ..	" "
3rd	March 11th ..	" ..	" "
4th	" 27th ..	" ..	Living agar culture.
5th	April 22nd ..	" ..	" "
6th	May 2nd ..	" ..	" "
7th	" 28th ..	" ..	" "
8th	June 17th ..	" ..	" "
9th	July 9th ..	" ..	Living gelatine culture.
10th	" 18th ..	" ..	" "
11th	" 31st ..	" ..	" "
12th	August 26th ..	" ..	" "
13th ?	September 16th ..	" ..	" "

Test *in corpore* of the blood of this animal was performed as follows :—Blood serum of the animal was mixed with living plague emulsion, and the mixture injected subcutaneously into

the groin of a guinea-pig, a like amount of living plague emulsion being at the same time injected into a control guinea-pig. The two animals were of about the same body weight. Thus :—

(1.) July 16th.—Guinea-pig No. 11 was injected with 100 cubic millimetres, 1000 cubic millimetres being equal to 1 cubic centimetre, of plague emulsion, *plus* 25–30 cubic millimetres of blood serum. At the same time 100 cubic millimetres of plague emulsion were injected into control guinea-pig No. 12.

Both guinea-pigs developed big buboes. The control guinea-pig died on the 13th day, the other guinea-pig which had received plague culture *plus* blood serum died on the 7th day; both of plague. That is to say, the control animal died later than the other. The blood serum had, therefore, had no effect whatever of neutralizing the fatal dose of plague culture.

(2.) July 29th.—Guinea-pig No. 17 was injected with a mixture of 100 cubic millimetres of plague emulsion and 50 cubic millimetres of blood serum. At the same time a control guinea-pig No. 18 was injected with 100 cubic millimetres of plague emulsion alone.

Guinea-pig No. 17 developed no bubo, and remained quite lively and well. Guinea-pig No. 18 on the other hand, showed distinct bubo on the 3rd day; this enlarged till the 8th day, then gradually diminished and disappeared, the animal quite recovering. This experiment is, therefore, faulty in this, that the control animal did not succumb to plague, the dose injected not proving a fatal dose. But the experiment apparently indicates that some inhibiting effect was produced by mixing the blood of the prepared guinea-pig with a dose of plague culture that served in a control animal to cause a distinct bubo. Referring to the table, it will be seen that at the date on which the blood serum was obtained from the guinea-pig No. 1 this animal had been injected three times with sterile culture, and seven times with small doses of living culture of plague bacillus, and that, therefore, by this time its blood seemed to contain some active germicidal substance although in a small amount.

(3.) August 10th.—Guinea-pig No. 26 was injected with a mixture of 100 cubic millimetres of emulsion and 100 cubic millimetres of blood serum. At the same time guinea-pig No. 27 was injected with 100 cubic millimetres of emulsion alone.

The control guinea-pig No. 27 died of plague on the 6th day, the other guinea-pig, No. 26, died of plague on the 7th day. This experiment does not denote the presence of germicidal substance in the blood of guinea-pig No. 1, even when serum and plague emulsion have been injected in equal amount.

The guinea-pig No. 1 had been injected on September 16th a thirteenth time, this time with a double dose of living gelatine culture. On October 17th the animal was killed, and it showed nowhere any pathological appearances. As already mentioned, its blood serum at this stage gave on agglutination test (dilution 1 : 20) completely positive result in 10 minutes. Its blood serum,

as also a salt extract of the spleen (this organ looked quite normal), were now used in the following manner :—

(1.) 200 cubic millimetres of plague emulsion were mixed with 200 cubic millimetres of blood serum, and the mixture injected into guinea-pig No. 40.

(2.) 200 cubic millimetres of plague emulsion were mixed with 50 cubic millimetres of blood serum, and the mixture injected into guinea-pig No. 39.

(3.) 200 cubic millimetres of plague emulsion were mixed with 200 cubic millimetres of thick spleen emulsion, and the mixture injected into guinea-pig No. 41.

(4.) 200 cubic millimetres of plague emulsion were injected into control guinea-pig No. 42.

The result was this : Guinea-pigs 42, 39, and 41 died of plague on the fifth day ; guinea-pig 40 died of plague on the sixth day. All the animals had typical bubo and enlarged spleen crowded with plague bacilli. From this it appears that neither the blood nor the spleen of guinea-pig No. 1 were capable of exerting any appreciable germicidal action. That the guinea-pig No. 1 was distinctly protected by September 16th is proved by the fact that an injection on that day of a considerable dose (certainly more than double the ordinary fatal dose) did not cause any illness whatever in this animal. As a matter of fact, sometime previous to the above date the guinea-pig did not react on the injection of an otherwise fatal dose of living plague culture. And yet the last named experiments prove that this animal possessed neither in its blood nor in its spleen those substances (antitoxins, germicidal substances, &c.) which we associate with protection, *i.e.*, substances produced by repeated injections of the microbe, as in diphtheria protection and cholera protection. It is justifiable, therefore, to conclude from the above very striking experiment that, as regards the guinea-pig, the injection (13 times) of the plague microbe does not result in the production of anti-bodies—germicidal substances—Pfeiffer's lysins in the experimental animal.

The second guinea-pig used for experiment was that already referred to as guinea-pig No. 4, page 368.

This animal had been injected at the following periods :—

No.	Date of Injection.	Method of Injection.	Material (and amount) Injected.
1st	May 6th ..	Intraperitoneal ..	Large dose of sterile gelatine culture.
2nd	„ 22nd ..	„ ..	„ „ „
3rd	June 5th ..	„ ..	„ „ „
4th	„ 14th ..	„ ..	Small dose of living gelatine culture
5th	July 9th ..	„ ..	„ „ „
6th	„ 18th ..	„ ..	„ „ „
7th	„ 31st ..	..	„ „ „
8th	August 27th ..	..	„ „ „
9th	September 16th ..	..	„ „ „

The test *in corpore* was made as follows :—

(1.) July 29th.—Guinea-pig No. 19 was subcutaneously injected with 100 cubic millimetres of living plague emulsion mixed with 50 cubic millimetres of blood serum. At the same time 100 cubic millimetres of the emulsion was injected into a control animal.

Both these animals remained alive. The experiment is therefore useless, the amount of living culture injected having been insufficient to cause death in the control animal.

(2.) August 9th.—The experiment was repeated. Guinea-pig No. 28 was subcutaneously injected with 100 cubic millimetres of living plague emulsion mixed with 100 cubic millimetres of blood serum of guinea-pig No. 4. At the same time 100 cubic millimetres of the emulsion were injected into a control animal.

The control guinea-pig died of plague on the sixth day; the other (No. 28) died of plague on the ninth day.

(3.) September 12th.—Guinea-pig No. 35 was subcutaneously injected with 100 cubic millimetres of living plague emulsion mixed with 100 cubic millimetres of blood serum. At the same time 100 cubic millimetres of the same emulsion were injected into a control guinea-pig.

The guinea-pig No. 35 died of plague on the fifth day; the control guinea-pig died of plague on the seventh day.

From this series confirmation of the previous result is obtained, viz., that even after several injections of living cultures into the peritoneum of the guinea-pig no germicidal substances are present in the blood of the protected animal in demonstrable amount.

Seeing then that no germicidal effect can be produced with the blood serum of guinea-pigs repeatedly injected with living culture, it was not to be expected that a positive effect could be produced with the blood serum of guinea-pigs repeatedly injected with the Haffkine prophylactic. But, nevertheless, experiments as to this were actually made, as follows :—

Guinea-pig No. 5, already mentioned (page 369) as having been injected subcutaneously with Haffkine prophylactic on seven separate occasions, furnished blood serum which was tested for the presence of germicidal substance 12 days after the fourth injection, and again 14 days after the sixth injection. The result in both instances was negative.

Guinea-pig No. 7, referred to at page 370 as having been injected intraperitoneally on eight separate occasions with Haffkine's prophylactic, furnished blood serum which was tested for germicidal effects after the fourth, and again after the seventh, injection. The result was in both instances quite negative.

In the face of these results I have not thought it expedient to test the blood serum of the guinea-pigs which had been injected with the filtrate *alone* of Haffkine's prophylactic.

(*b.*) *Rabbits.*—The blood serum of the following three protected rabbits was submitted to the germicidal test, namely :—

Rabbit No. 1, referred to at page 371 as having been *intravenously* injected at first (three times) with sterile, then (twice) with small doses of living culture; rabbit No. 3, referred to at page 372 as having been repeatedly injected *subcutaneously* with Haffkine's prophylactic; and rabbit No. 5, referred to at page 373 as having been repeatedly injected, first *intravenously* and then *subcutaneously*, with Haffkine's prophylactic.

Rabbit No. 1.—Test of this rabbit's serum was made on July 16th, that is to say, one week after the fourth intravenous injection.

(*a.*) 100 cubic millimetres of plague emulsion, mixed with 50 cubic millimetres of the blood serum were injected into guinea-pig No. 13.

(*b.*) 100 cubic millimetres of plague emulsion mixed with 100 cubic millimetres of the blood serum were injected into guinea-pig No. 14.

The result was negative; both animals died of plague, No. 13 on the sixth day, No. 14 on the seventh day.

Rabbit No. 3.—The blood serum of this rabbit was tested on July 15th, *i.e.*, after the second subcutaneous injection with Haffkine's prophylactic.

100 cubic millimetres of plague emulsion mixed with 100 cubic millimetres of its blood serum were injected into guinea-pig No. 9.

This animal (No. 9) died on the fourth day of typical plague.

The test was repeated on July 31st, *i.e.*, 13 days after the third injection of 10 cc. of Haffkine's prophylactic.

100 cubic millimetres of plague emulsion mixed with 100 cubic millimetres of the blood serum were injected into guinea-pig No. 23; and at the same time 100 cubic millimetres of the emulsion alone were injected into control guinea-pig No. 24.

The control (No. 24) died on the eighth day, the other guinea-pig (No. 23) died on the 12th day.

The test was repeated on the 26th August, again with negative result.

Rabbit No. 5.—The blood serum of this rabbit was tested on three different occasions—16th of July, 31st of July, and 26th of August. But, as was the case with rabbit No. 3, the result proved negative in all three instances.

As regards rabbits, Nos. 3 and 5, the test on the last occasion, viz., August 26th, was altered in this way. Instead of mixing equal parts of plague emulsion and blood serum, a double volume of blood serum was used, viz., 100 cubic millimetres of plague

emulsion were mixed with 200 cubic millimetres of blood serum. The guinea-pigs injected with the mixture died, notwithstanding, of typical plague.

From these experiments it follows that, as with the guinea-pig so with the rabbit, neither repeated intravenous or subcutaneous injection, first of sterile and then of living culture, nor repeated subcutaneous or intravenous injection of Haffkine's prophylactic, produces germicidal substances in the blood of this animal in a way to render its serum serviceable for neutralising the fatal effect upon the guinea-pig of a dose of living culture of plague bacillus. It will have been noticed from the above control experiments that the dose of plague emulsion, viz., 100 cubic millimetres, generally used, was by no means a large dose, since some of the control guinea-pigs did not die, while in most instances death was delayed. It will be remembered from my Report 1896–1897 that the normal fatal dose for a guinea-pig is the one that kills a half-grown animal between 48 and 72 hours. In the cases now in question some of the (control) animals die as late as the seventh or eighth days.

(c.) *Rats.*—One rat, which had been twice *subcutaneously* injected with Haffkine's prophylactic (November 21st and December 31st, *see* page 376), was killed on January 30th.

250 cubic millimetres of plague[1] emulsion mixed with 250 cubic millimetres of blood serum of above rat were injected into one rat, No. 1, and

250 cubic millimetres of emulsion only into a control rat, No. 2.

Both animals died of plague, No. 1 on the fifth, No. 2 on the fourth, day.

A further experiment was the following :—

A rat which had been protected by a first injection of 10 cc. of Haffkine's prophylactic was a week later injected with an ordinarily fatal dose of living plague culture. The animal developed a bubo that suppurated and which in the course of two weeks had completely healed up. This rat was killed about five weeks after the first injection, about two to three weeks after the last, and its blood serum tested *in corpore* both on a guinea-pig and on a rat. In each case 250 cubic millimetres of living plague emulsion were mixed with 250 cubic millimetres of blood serum. Both animals died of plague, as did the control in each instance.

It follows from these experiments that no conspicuous amount of germicidal substance is produced in the rat when it has been efficiently protected, whether by Haffkine's prophylactic alone or by passing in addition through a mild form of the plague.

Plague therefore differs from some other infective diseases (cholera, diphtheria, &c.) in the circumstance that a previous immunisation of an animal against plague does not necessarily create in this animal an appreciable amount of germicidal substance which may be in turn used for conferring either passive immunity on a fresh animal or for neutralising a fatal dose of living plague culture.

(VI.) *CONSTITUTIONAL CHANGES IN ANIMALS INJECTED WITH PLAGUE PROPHYLACTIC.*

In order to supply means of comparing the effects of injections of the plague prophylactic, I submit here a tabular account of the changes of the temperature and of body weight of rabbits submitted to injection of at first sterile afterwards living (solid) culture of B. pestis, as described in series II., 5 and 6.

Rabbit No. 1.

First subcutaneous injection, May 6th, with sterile culture :—

—	Temperature, 12 noon.	Body Weight.	—	Temperature, 12 noon.	Body Weight.
	° F.	Grammes.		° F.	Grammes.
Before injection ..	102·6	1155	May 16th	103·4	1160
May 7th	105·3	1105	" 17th	102·8	1122
Animal off its feed.			" 18th	102·7	1148
May 8th	104·4	1090	" 20th	103	1097
Animal appears all right and feeds again.					
May 9th	104	1115	" 21st	103·1	1074
" 10th	102·6	1067	" 22nd	102·5	1090
" 11th	104·8	1068	" 23rd	103·3	1090
" 13th	103	1065	" 24th	103	1103
" 14th	103·2	1089	" 25th	103·2	1128
" 15th	102·4	1115			

Second intravenous injection with sterilized culture on May 28th :—

—	Temperature, 12 noon.	Body Weight.	—	Temperature, 12 noon.	Body Weight.
	° F.	Grammes.		° F.	Grammes.
Before injection ..	103·2	1102	May 6th	103·6	1267
May 29th	103·8	1129	" 7th	103·6	1315
" 30th	104·4	1108	" 8th	103·4	1302
" 31st .. .	103·3	1126	" 10th	103·2	1281
June 1st	103·3	1144	" 11th	103·8	1283
" 3rd	102·4	1146	" 12th	103	1266
" 4th	103	1180	" 13th	103·3	1313
" 5th	103	1221			

Third injection of the rabbit per ear vein with sterilized culture :—

—	Temperature, 12 noon.	Body Weight.	—	Temperature, 12 noon.	Body Weight.
	° F.	Grammes.		° F.	Grammes.
June 14th	103·7	1284	June 22nd	103·5	1319
" 15th	104·4	1303	" 24th	102	1319
" 17th	102·6	1269	" 25th	102·8	1312
" 18th	102·6	1242	" 26th	103	1325
" 19th	101·6	1277	* * * *	* *	*
" 20th	102·5	1343	July 9th	103	1281
" 21st	102·4	1281			

Fourth intravenous injection with small dose of emulsion of living culture :—

—	Temperature, 12 noon.	Body Weight.	—	Temperature, 12 noon.	Body Weight.
	° F.	Grammes.		° F.	Grammes.
July 10th	102·6	1310	July 16th	106·5	1353
" 11th . ..	105·1	1355	" 17th	104	1273
" 12th	106·1	1352	" 18th	105	1286
" 13th	106·4	1324	" 19th	103·6	1245
" 15th	106·8	1345	" 20th	103·4	1177

Rabbit No. 2.

First intravenous injection with sterilized culture on May 6th :—

—	Temperature, 12 noon.	Body Weight.	—	Temperature, 12 noon.	Body Weight.
	° F.	Grammes.		° F.	Grammes.
Before injection ..	102·5	1105	May 17th	102·7	1061
May 7th	104	1069	" 18th	102·8	1088
" 8th	104	1015	" 20th	103	1097
" 9th	104	1062	" 21st	102·8	1071
" 10th	103·7	1046	" 22nd	102·8	1102
" 11th	106	1039	" 23rd	102·7	1113
" 13th	103·7	1031	" 24th	103	1109
" 14th	103	1062	" 25th	102·7	1138
" 15th	103	1095	" 28th	102·8	1093
" 16th	103·4	1124			

Second intravenous injection with sterilized culture :—

—	Temperature, 12 noon.	Body Weight.	—	Temperature, 12 noon.	Body Weight.
	° F.	Grammes		° F.	Grammes
May 29th	103·8	1098	June 6th	103·2	1208
„ 30th	103·8	1080	„ 7th	104	1286
„ 31st	103·1	1102	„ 8th	103	1288
June 1st	103·4	1121	„ 10th	102·6	1250
„ 3rd	103	1132	„ 11th	103·6	1296
„ 4th	103·4	1154	„ 12th	102·8	1296
„ 5th	103	1179	„ 13th	103·2	1279

Third intravenous injection with sterilized culture :—

—	Temperature, 12 noon.	Body Weight.	—	Temperature, 12 noon.	Body Weight.
	° F.	Grammes.		° F.	Grammes.
June 14th	103·6	1256	June 20th	102·4	1322
„ 15th	103·4	1287	„ 21st	102·4	1283
„ 17th	103	1261	„ 22nd	103·4	1310
„ 18th	102·4	1243	„ 24th	103·2	1349
„ 19th . ..	102·4	1275	„ 26th	103	1409

From these records it appears that :—

(1.) No definite conclusion can be drawn from the alteration of body weight as to whether or not the injection of sterile or even of living culture exerts any influence on the animal's metabolism.

(2.) The injection of sterile culture appears to cause a distinct and immediate (in 24 hours) rise of the body temperature, which lasts a few days. The second injection of the same culture causes a renewed rise of temperature, but this sets in not 24 but 48 hours after the injection, and is of shorter duration than that following the first injection. From the experiment on rabbit No. 1 it is further seen that intravenous injection of living culture following on a third intravenous injection of sterile culture causes, on the second day, a very considerable rise of the body temperature lasting for more than a week. It is curious, however, to find that the animal did not lose in weight till the temperature again commenced to fall. But as mentioned above the body weight is of

very uncertain value. It has to be added in this connexion that the animals were always kept as to food and all other conditions under precisely the same favourable conditions.

App. B, No. 1. On the Nature of Haffkine's Plague Prophylactic; by Dr. Klein, F.R.S.

Rabbit No. 3.

First subcutaneous injection with 10 cc. Haffkine prophylactic on June 17th :—

—	Temperature, 12 noon.	Body Weight.	—	Temperature, 12 noon.	Body Weight.
	° F.	Grammes.		° F.	Grammes.
Before injection ..	102·3	1176	June 24th	102·6	1161
June 18th	106·5	1129	„ 25th	102·2	1167
„ 19th	106·4	1262	„ 26th	102·6	1185
„ 20th	103·7	1138	„ 27th	102·1	1193
„ 21st	101·7	1110	„ 28th	102	1186
„ 22nd	102·5	1150	„ 29th	101·4	1138

As has been recorded in connexion with various experiments here reported on, this animal was injected and re-injected subcutaneously a 2nd, 3rd, 4th, 5th, and 6th time on each occasion with 10 cc., and a 7th and 8th time on each occasion, with 20 cc., of Haffkine's prophylactic. But there was no corresponding alteration observed in the body temperature. The body weight, however, was constantly varying upwards and downwards in an erratic fashion. It is, however, seen that the first injection caused a sudden and considerable rise of temperature, lasting for two or three days; that is to say, a change of the same kind as was noted in the case of rabbit No. 1 after the first *intravenous* injection of that animal with sterilized bacteria taken from solid medium. *Subcutaneous* injection therefore into a rabbit of under 1,200 grammes weight of 10 cc. of the plague prophylactic caused the same decisive constitutional disturbance, as manifested by a rise of body temperature of over 3° F., as did *intravenous* injection of a mass of bacilli amounting to three-fourths of the growth uniformly covering the slanting surface (6 centimetres by 2 centimetres) of an agar culture. It is important to bear this in mind, since the fact will again be referred to when comparison is made of the relative merits of injection of sterilized (solid) culture and of Haffkine's (broth) prophylactic. In order to show that this constitutional disturbance, *quâ* body temperature, is real, I mention here an experiment made on a companion rabbit, No. 4, which animal unfortunately succumbed immediately after the second injection, and on post-mortem examination was found to be affected with extensive psorospermosis.

APP. B. No. 1.

On the Nature of Haffkine's Plague Prophylactic; by Dr. Klein, F.R.S.

Rabbit No. 4.

First subcutaneous injection of 10 cc. plague prophylactic on June 17th :—

—	Temperature, 12 noon.	Body Weight.	—	Temperature, 12 noon.	Body Weight.
	° F.	Grammes.		° F.	Grammes.
Before injection ..	102·6	1367	June 24th	103·6	1365
June 18th	105·5	1315	„ 25th	103·2	1360
„ 19th	105·7	1333	„ 26th	103	1364
„ 20th	103·2	1331	„ 27th	102·6	1350
„ 21st	102·6	1292	„ 28th	102·4	1321
„ 22nd	103	1340	„ 29th	102·2	1255

There is here decided rise of temperature (3° F.) the day after the injection, and this was maintained on the day following. Also there is observed a curious initial fall of body weight, with rise again as the temperament decreased after an initial rise.

Rabbits Nos. 5 *and* 6.

Both these animals were for the first time injected *intravenously* on July 1st with 5 cc. of Haffkine's prophylactic.

—	Temperature, 12 noon.		Body Weight.	
	No. 5.	No. 6.	No. 5.	No. 6.
	° F.	° F.	Grammes.	Grammes.
Before injection	102·1	102·4	1395	1605
July 2nd	103·9	104·8	1336	1514
„ 3rd	103·6	104·2	1326	1543
„ 4th	103·8	103	1321	1526
„ 5th	103·2	103	1320	1590
„ 6th	104	104·6	1363	1565
„ 8th	102·6	102·8	1300	1506
„ 9th	103·1	103	1288	1493
„ 10th	102·6	102·4	1282	1490
„ 11th	102·1	102·4	1275	1489
„ 12th	103	103·1	1270	1497
„ 13th	103	103·4	1233	1486
„ 15th	102·8	102·7	1253	1515
„ 16th	102·5	102·4	1224	1504
„ 17th	102	103·3	1110	1480
„ 18th	102	103·6	1121	1483
„ 19th	103·2	103·8	1163	1432

App. B, No. 1. On the Nature of Haffkine's Plague Prophylactic; by Dr. Klein, F.R.S.

From this it appears that intravenous injection of the prophylactic was followed by a little less decisive rise of temperature than was subcutaneous injection in the former cases. The body weight fluctuated considerably; fluctuation which was on the whole fairly parallel for the two animals, that is to say, when it rose in one it rose also in the other rabbit, and *vice versâ.*

Rabbits Nos. 7 and 8.

These two animals, as mentioned at page 376, were injected subcutaneously with 20 cc. of the *filtrate* of Haffkine's prophylactic on three separate occasions.

First subcutaneous injection of 20 cc. of the filtrate on September 10th :—

—	Temperature, 12 noon.		Body Weight.	
	No. 7.	No. 8.	No. 7.	No. 8.
	° F.	° F.	Grammes.	Grammes.
Before injection	103	103·4	1645	2120
September 11th	104	103·7	1638	2155
„ 12th	103·2	102·4	1651	2169
„ 13th	103	102·6	1688	2196
„ 14th	102·8	103·1	1697	3207
„ 16th	102·4	102·4	1640	2170
„ 17th	102·5	103·3	1604	2110

Second injection with 20 cc. of the filtrate :—

—	Temperature, 12 noon.		Body Weight.	
	No. 7.	No. 8.	No. 7.	No. 8.
	° F.	° F.	Grammes.	Grammes.
September 18th	104	103	1670	2169
„ 19th	103·2	102·3	1626	2123
„ 20th	103	102·1	1671	2138
„ 21st	102·6	103·4	1653	2128
„ 23rd	102·4	102	1614	2072

It appears from this series that the first injection of 20 cc. of the filtrate did not cause any but an insignificant rise of the body temperature (0·2° F. in rabbit No. 7, 0·3° F. in rabbit No. 8), a rise so small as to be well within the limits of natural fluctuation. The second injection of 20 cc. of the filtrate appears to have been a little more active in temporarily raising the body temperature (1·5° F. in rabbit No. 7, 0·8° F. in rabbit No. 8); but here also

the rise is not sufficiently striking to warrant assumption of any specific action. It is possible that the effect of injecting subcutaneously 20 cc. of any fluid containing in solution chemical substances of various composition, such as naturally result from the long continued (four to six weeks) growth of bacteria in broth, would be similar as regards temperature. However this may be, it is certain that the blood of these animals did not contain agglutinating substances even after the fourth injection of 20 cc. of the filtrate.

(VII.) *OBSERVATIONS AS TO PROTECTION AGAINST PLAGUE INFECTION CONFERRED ON ANIMALS BY PREVIOUS INJECTION OF HAFFKINE PLAGUE PROPHYLACTIC.*

A.—*Guinea-pigs.*

From the experiments recorded in Section I., it will have been obvious that repeated injection of the dead (*i.e.*, sterilized) bacilli taken from the surface of solid media confers on the guinea-pigs and rabbits a certain degree of immunity. The subsequent injection of living culture of B. pestis did not cause a fatal issue. But as in 1896–1897, so also now, the immunity thus conferred on the guinea-pig, viz., by this injection of sterilized bacilli, was not of a high order, since on each subsequent subcutaneous injection of living culture the animals reacted, as shown by the development of a bubo on the inoculated side, which bubo soon, however, suppurated and healed up. I have at present in the laboratory a guinea-pig which exactly a year ago, May 6th, was injected the first time with the growth scraped from the whole surface (6 centimetres by 2 centimetres) of a gelatine culture of B. pestis. The growth was sterilized as a salt emulsion and then injected intraperitoneally; and injection in this way was repeated in the same amount on May 22nd and on June 5th. The animal was then injected intraperitoneally with small doses of *living* culture on eight separate occasions. Finally, on December 28th, it was injected subcutaneously with an ordinary lethal dose of living culture. The animal remained alive, but it developed a fair bubo, which suppurated and healed up in about a fortnight.

On May 15th, 1901, a year that is after the first injection, it was injected—for the 13th time—subcutaneously with an ordinary lethal dose of plague material. The animal remained alive and fairly lively, and it fed well, but it again developed a bubo in the inguinal region which extended onto the thigh and became nearly as big as a pigeon's egg. This bubo suppurated by the end of a week and had not quite healed by the end of a fortnight.

This is by no means an isolated instance as regards the guinea-pig. I have had several such cases in 1896–97 (*see* my Report), and

I have quite a number of similar instances in the present investigation. All show that a high degree of immunity in the guinea-pig does not exist even after a good many previous injections of sterilized and also living plague bacilli. The animals acquire no doubt a certain resistance against fatal infection, but this resistance does not prevent the development of a well-marked bubo with living bacilli in the early stages.

In view of this experience, it was not to be expected that the injection of the Haffkine prophylactic could produce results more favourable than the repeated injection of living plague bacilli. In 1899–1900, with Professor Haffkine, at the instance of the Board, I made a number of experiments with the Haffkine plague prophylactic. In these a series of guinea-pigs received by a single subcutaneous injection various amounts of the plague prophylactic, 5 cc., 10 cc., 30 cc., 40 cc., and even 60 cc. They were subsequently injected with lethal dose of living plague bacilli, as were, at the same time, a similar series of control guinea-pigs. The result was this:—Of the eight control guinea-pigs all died of plague. Of the eight prepared guinea-pigs seven died of plague; in the eighth animal the bubo suppurated and ultimately healed. During this year's experiments several guinea-pigs were, as mentioned in a previous section, repeatedly (as often as eight times) injected (subcutaneously and intraperitoneally) with Haffkine prophylactic, and afterwards with living culture. They developed typical bubo. I have at present a guinea-pig which had been injected eight times intraperitoneally with Haffkine prophylactic between June 17th and October 21st, receiving altogether 51 cc. of the fluid. On the 28th December it was injected subcutaneously with small dose of living culture of B. pestis. It developed typical bubo. On May 5th of this year it was again injected with an ordinarily lethal dose. It remained alive, but by the end of the week it had a bubo of the size of a pigeon's egg.

The same negative results were obtained by injecting guinea-pigs with the clear filtrate of Haffkine's prophylactic; and it is not necessary to detail them beyond noting that neither the subcutaneous nor the intraperitoneal injection of 10 cc. in each instance of this clear filtrate on three separate occasions (within six weeks) had any influence in inhibiting the ordinary results of subsequent injection of small and large doses of living bacilli pestis.

B.—*Rabbits.*

The experiments made in conjunction with Professor Haffkine on rabbits, although numerous, were on the whole of an unsatisfactory nature, mainly because of the difficulty and uncertainty in ascertaining what is a normal fatal dose of plague culture for the rabbit. A large series of rabbits were carefully noted as to body temperature and body weight, before and after injection, with varying amounts of the prophylactic (10 cc. to 34 cc.).* Control

* I note with surprise the statement by Professor Balfour Stewart (Thompson-Yates Laboratory, Vol. II., p. 19) that he found 2 cc. of the Haffkine prophylactic sufficient to immunise a rabbit of 1,400 grammes body weight.

rabbits, equally carefully noted as to body weight, were kept separate, but corresponded as nearly as possible in body weight to the prepared rabbits. In due time each animal in both sets was injected with what ought to have been a fatal dose of living plague culture. The result was disappointing, because an equal proportion of prepared rabbits and control rabbits succumbed to plague. The percentage of deaths in each class of rabbit was, however, less than 50, whereas in the case of both guinea-pigs and rats (used as controls) a fatal issue can always be insured.

The experiments which I have made in the course of the present year on rabbits with sterilized solid plague culture, with Haffkine prophylactic, and with the filtrate of the prophylactic, were of an equally unsatisfactory nature, and for the same reason, viz., unless extra large doses of living plague culture be injected (against which, of course, no prophylactic would be efficacious) the control animals were not killed.

A series of rabbits were prepared, some by repeated injection of sterilized solid culture, others by repeated injection of Haffkine prophylactic, and still others by repeated injection of the filtrate of Haffkine prophylactic

At the proper phase of the experiment they, as also corresponding rabbits (*i.e.*, corresponding in body weight), were injected with what in a preliminary experiment on a control rabbit acted as a fatal dose, *i.e.*, half of a gelatine culture (6 centimetres by 2 centimetres surface) three days old. Unfortunately this crucial experiment failed to elucidate the point and to answer the question, viz., whether or no any, and if so which, of the prepared rabbits were protected. The control rabbits did not any of them die.

I have not, therefore, repeated the experiments, because I think it proved that, owing to its varying and unstable susceptibility, the rabbit is not a suitable animal for this kind of experiment

C.—*Rats.*

1. *Action of the complete Haffkine plague prophylactic.*—Fortunately in the rat we possess a test animal which, in my experience, is thoroughly reliable. I have in the course of preparing the large amounts of the Haffkine plague prophylactic (about 60,000 doses) invariably used rats for testing this prophylactic, and my test has always been carried out in the following manner:—With each particular brew (comprising 6–12 flasks of the same broth, inoculated at the same time under the same conditions, decanted, sealed, and sterilized at the same time) I have generally inoculated four rats, each being made to receive subcutaneously 10 cc. of the finished product. Except in the earliest experiments, white rats, half to full grown, have been employed, as I find these highly susceptible to plague, much easier to handle, and less liable to accidental and spontaneous death than the brown (wild) sewer or house rat.

Eight to ten days (on occasion 12 days) after this injection with the prophylactic the prepared rats, together with two fresh or unprepared rats, are injected with *living* plague culture, in amount sufficient to cause death from typical plague in both controls, while permitting the prepared rats to remain (if protected) alive. As a result of my experience in the above tense of a considerable number of brews of the prophylactic on a considerable number of rats, I am prepared emphatically to maintain that 10 cc. of the Haffkine prophylactic is capable of fully protecting a rat (half-grown to adult) against a subsequent injection of a dose of living plague culture that acts lethally without fail on control rats. And a similar experience was obtained in association with M. Haffkine, when he and I tested on rats the prophylactic brought by him from Bombay, viz., those which received an injection of 10 cc. of the prophylactic withstood subsequent infection with living culture of B. pestis.

It is not necessary to detail all the above experiments that were made on the rats with the prophylactic prepared by me here in London. I have already given their general purport, and I therefore proceed to describe the equally satisfactory results which I obtained with the sterilised bacillary bodies from the prophylactic, as also the results of certain experiments with the clear filtrate after removal of the bacilli.

2. *Action of sterilized bacillary bodies.*—The bodies of the sterilized bacilli were employed in the form in which they occur in the Haffkine prophylactic. The manner of obtaining them was very simple. As mentioned by me in the introduction to this report, the prophylactic was preserved by me in sealed tubes without the addition of any preservative, each tube containing 30 to 32 cc. When left standing upright all the bacillary bodies settle at the bottom of the tube, whereas the fluid above becomes and remains quite limpid. From such a tube—after opening it by breaking the sealed end—the fluid is siphoned off, a process very easily achieved. The remaining sediment is then distributed in salt solution in amount equal to the quantity of broth siphoned off. Of this emulsion 10 cc. are used subcutaneously per rat. As a matter of fact, the 30 to 32 cc. of the fluid in a given tube, salt solution plus bacillary sediment, were used for three rats. The result was complete protection in each instance by this preliminary injection against the subsequent injection of living culture. I have made two series of such experiments, each comprising three prepared rats and one control, and in both series the result was positive, viz., death of the control rat and survival of the prepared animals.

3. *Action of the filtrate* per se *of Haffkine's prophylactic.*—From what has just now been stated, viz., that practically the bacillary sediment and the complete Haffkine prophylactic are equally protective, it was to be inferred that the fluid itself—*i.e.*, the broth in which the bacilli had been growing, but minus the bacilli—is of no use in assisting or in sharing in the protective action of the Haffkine prophylactic. As a matter of fact, the Indian Plague Commission deny (Vol. V.) any action, toxic or otherwise, of this fluid, *per se*, and as far as can be gathered from

the questions put by some of the members of the Commission to Prof. Haffkine during his examination before the Commission in Bombay, it seems as if Prof. Haffkine had been reproached for having used broth culture (of course, sterilized) as plague prophylactic, seeing that his cholera prophylactic was an emulsion made from the growth of the cholera vibrio on solid media. And, further, Calmette, in his Harben Lectures (1900), assumes that all the prophylactic action of a sterilized culture is and must necessarily be lodged in the bacillary bodies themselves. Moreover, Prof. Haffkine, himself, has repeatedly pointed out (*see* his evidence before the Plague Commission) the importance of copious bacillary growth in his broth culture; as a matter of fact, the prophylactic dose recommended per human individual has in practice been estimated according to the amount of bacillary growth in the flask, the amount of the dose being in inverse ratio to the turbidity, *i.e.*, amount of bacillary growth.

While all these are facts of common knowledge, I venture seriously to doubt the assumed inefficacy and superfluity of the fluid part of the prophylactic. And my doubts are based on good experimental grounds as follows:—

(*a.*) Four half-grown rats were injected with filtrate of the prophylactic, *i.e.*, with the clear fluid siphoned off from a tube (*see* above), and passed through a Pasteur-Chamberland filter. Each rat received subcutaneously 10 cc. of this filtrate on two separate occasions, November 21st and December 31st. On February 6th, *i.e.*, 37 days later, they were injected with a dose each of living culture which killed a control rat on the fourth day. Of the four prepared rats, two died of plague on the fifth day, the nature of this fatal malady being confirmed on microscopic, macroscopic, and cultural evidence. The two others survived.

(*b.*) Four half-grown rats received each 10 cc. of this filtrate on March 11th, and again 10 cc. on March 18th. On May 5th they were injected with living plague culture at the same time that a control rat received an equal dose of this infection. The result was instructive. The control rat died of typical plague on the third day; one of the prepared rats died of plague on the fourth day; another of the prepared rats died of plague on the sixth day; a third of these prepared rats died of plague on the twelfth day. But the fourth survived.

From these experiments I think it is justifiable to conclude that, although the effect of the filtrate (20 cc. per animal) was small, it was nevertheless of a positive nature, since the prepared animals behaved somewhat differently from the control rats. Some of the former were found distinctly protected, while those not protected died always later than the control rats.

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REPORT on the CHEMICAL PRODUCTS of DIARRHŒA-PRODUCING BACTERIA; by Dr. SIDNEY MARTIN, F.R.S.

App. B, No. 2.

On the Chemical Products of Diarrhœa-producing Bacteria; by Dr. Martin, F.R.S.

Diarrhœa, or looseness of the bowels, may be produced by many different causes, which may be divided into three great groups:—

1. The mechanical causes, such as those associated with indigestible food or foreign bodies in the intestinal tract.
2. Chemical causes, those due to the action of drugs.
3. Bacterial causes, which are the subject of this preliminary communication.

Although diarrhœa is only a symptom yet it may be the main symptom in certain bacterial diseases, and the investigation therefore of the chemical substances produced by such bacteria must be regarded as an important part of the pathological and even curative study of these diseases.

A general classification of the bacterial causes of diarrhœa is made by dividing them into those which are "infections" and those which are "intoxications"

Of the class of "infections" there are several groups which require consideration.

1. With one group there is associated definite lesion (ulceration) of the intestinal coat, with or without a subsequent infection of the body by the bacterium. Thus in typhoid fever there is ulceration of the intestine, and the typhoid bacillus is found not only in the local lesion but in the mesenteric glands, in the spleen, and in some cases in other parts of the body. In dysentery (not due to amœba dysenteriæ) there is the local lesion of ulceration, but there is not to any great extent, as is at present known, invasion of the body by the bacillus dysenteriæ.

2. A second group of infective diarrhœa includes cholera, in which there is a large growth of the specific vibrio in the intestinal tract and a partial infection of the mucous membrane with shedding of the epithelium, but to no great extent, if at all, are the tissues of the body infected by the bacterium. Into this group apparently come many of the cases of food poisoning, whether due to the bacillus enteritidis of Gärtner or to the bacillus enteritidis sporogenes, as well as some cases of infective diarrhœa which are due to a streptococcus or are associated with pyæmia and septicæmia.

In some of the cases of food poisoning, as well as in diarrhœa associated with septicæmia, there may be a local lesion of the gut, thus approximating the second group of infective diarrhœas to the first.

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The diarrhœas associated with "intoxication" are mainly due to putrefactive processes occurring in the intestinal tract, and in some, at any rate, of these cases there is no local lesion of the mucous membrane and no infection of the body. The part which the bacillus coli communis plays in such conditions is not yet accurately defined, but inasmuch as this micro-organism cannot exist in the presence of numerous putrefactive bacteria, it can play but little rôle in the production of the diarrhœa associated with putrefaction of the intestinal contents.

A common putrefactive bacterium in the intestinal contents is the proteus vulgaris. This is also a pathogenic bacterium, and to its action is ascribed many of the putrefactive diarrhœas of children and of adults.

In considering how best to study the subject from a chemical and physiological stand-point, it was determined to contrast the action of the products of some of the bacteria of the infective group with those of the putrefactive bacterium—the proteus vulgaris. The organism of the infective group selected for investigation was the bacillus dysenteriæ (Shiga, Flexner, Krüse), which has been found in both European and tropical dysentery.

THE BACILLUS DYSENTERIÆ.

(*Shiga, Flexner, Krüse.*)

This bacterium is allied to the typhoid bacillus and to the bacillus coli communis, from both of which, however, it differs in some particulars. It was found by Krüse in the dejecta in some cases of dysentery occurring in Germany, by Shiga in the dysentery occurring in Japan, and by Flexner in this disease occurring in the Philippines; all three observers working independently.

The bacilli isolated by these observers are probably identical, although some differences among their recorded characteristics are to be noted.

Krüse gives the characters of the bacillus separated by him, along with particulars which morphologically bring the bacillus into close relationship with the typhoid bacillus. Thus, on agar and glucose agar the growth is like this bacillus, and it also agrees with that of the typhoid bacillus in producing no gas in a glucose medium. It does not coagulate milk; it forms a slightly yellow growth on potato, and it does not liquefy gelatin. It is aërobic and a facultative anaërobe. It is a bacillus somewhat stouter than the typhoid bacillus, and it has no spores. It is not stained by Gram. Krüse said the bacillus obtained by him was motionless, and other investigators have observed the same fact.

Flexner's, as well as Shiga's, bacillus showed a feeble motility, which is not nearly as active as that of the typhoid bacillus. Flagella have been demonstrated. The bacillus is readily killed

by exposure to heat, from half to one hour at 50° to 60° C. being sufficient for this purpose. The serum reaction of the bacillus is important. This has been performed with the serum from patients the subjects of dysentery. Krüse found the reaction, as observed in different dilutions, from one in 1,000 to one in 50. Flexner also observed the serum reaction of patients, and made the further observation that dysenteric blood which gave a positive reaction with the bacillus was quite negative against the typhoid bacillus.

These results tend to show that in epidemic dysentery in Europe, in America, and in the tropical dysentery such as occurs in the Philippines and Japan, a specific micro-organism is found in the motions which, while resembling the typhoid bacillus and the bacillus coli communis in certain particulars, may be differentiated from these by slight morphological features, but more particularly by the specific serum reaction (agglutination).

I received a recent culture of Krüse's bacillus dysenteriæ through the kindness of Dr. A. Grünbaum, of University College, Liverpool. The cultural characteristics of this specimen were as follows:—

In broth there was turbidity and deposit but no scum. On agar the growth was like that of the typhoid bacillus. On stroke-gelatin the growth was glassy in appearance and the medium was not liquefied. In shake-gelatin a copious growth occurred, especially near the surface, but no liquefaction ensued; and in glucose-gelatin (shake) no bubbles of gas appeared. Milk was not coagulated although the tube was incubated for 18 days. On potato a colourless filmy growth appeared, which did not become yellow subsequently. The bacillus was feebly motile, and was distinguishable from the typhoid bacillus by being somewhat plumper and but with little tendency to form long threads in broth culture.

The virulence of this bacillus was tested in guinea-pigs. A culture was made in broth and incubated for 24 hours. Two guinea-pigs were inoculated intraperitoneally: one, weighing 240 grammes, with 5 cc. of the broth culture, and the other, weighing 210 grammes, with 2 cc. The inoculations were made at 5 p.m. and both animals were found dead in the morning. The post-mortem showed a turbid peritoneal effusion in both cases. 2 cc. of this effusion from one of the animals were injected intraperitoneally into another guinea-pig weighing 243 grammes. Cultures of the peritoneal effusion in broth and on slope agar showed a pure and copious growth. The inoculated animal died in under 24 hours and showed peritoneal effusion, as before containing a pure growth of the bacillus dysenteriæ. 0·9 cc. of the effusion was intraperitoneally injected into another guinea-pig weighing 222 grammes, with a fatal result in under 24 hours. Cultivations from the peritoneal effusion of this guinea-pig gave a pure growth, and from the heart's blood a pure growth of the bacillus was also obtained.

The bacillus was therefore pathogenic to guinea-pigs, and more obviously so than the typhoid bacillus. An ordinary culture of

the typhoid bacillus does not so uniformly kill guinea-pigs by intraperitoneal injection as did the cultures of the dysentery bacillus I used, nor does it produce an infection of the body so readily.

Products of the Bacillus Dysenteriæ (Krüse).—An investigation was made to determine: (1) Whether the bacillus formed any soluable chemical products when grown in a peptone broth medium, or in a broth medium to which serum had been added; (2) or whether the toxic substances were present chiefly in the bodies of the bacillus.

Cultivation in Broth.—A flask containing 100 cc. of peptone broth was inoculated with the bacillus and incubated at 37° C. for 18 days. A copious growth occurred, which, on testing at the end of the period of incubation, was found to be pure. The broth was filtered through a Chamberland filter and used for inoculation intravenously in a rabbit. As shown in the chart (I.), the rabbit weighing 2,120 grammes received intravenously 4 cc. of the broth filtrate. The result on that day was

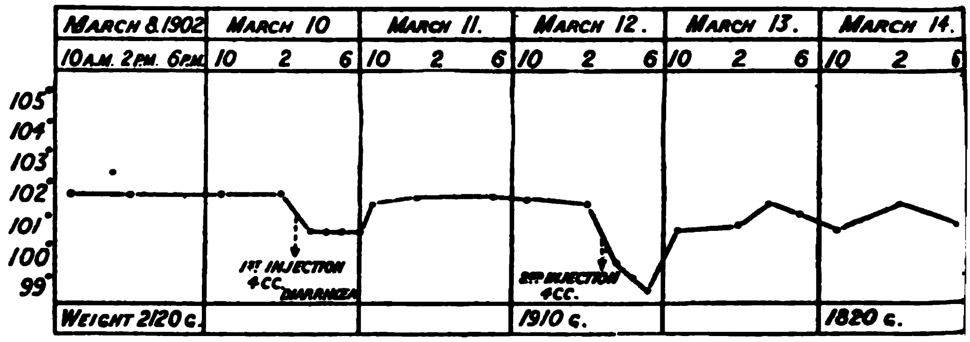

CHART I.—Intravenous injection in rabbit of two doses (each 4 cc.) of filtrate of an 18 days' culture of the B. dysenteriæ in peptone broth.

the lowering of temperature by nearly 1·5° and the production of diarrhœa. On the day but one following the animal received another dose of 4 cc. intravenously. The result was a marked lowering of the body temperature (taken in the rectum) by over two degrees. Although the temperature rose somewhat on the next day the temperature remained below the normal for several days, and this subnormal temperature was accompanied by a loss of weight of 540 grammes during nine days of experiment.

It is quite obvious, therefore, from this experiment that a soluble poisonous body is formed by the bacillus even after 18 days' growth in broth, and that the effect of this substance or substances is to produce a lowering of the body temperature in rabbits, with initial production of diarrhœa and a continued loss of body weight.

1. *Growth in Broth and Serum.*—The bacillus was grown in a mixture of 100 cc. of peptone broth, to which were added 20 cc.

of filtered sterile sheep serum. The incubation lasted 18 days at 37° C., at the end of which time the liquid was sterilised by chloroform, being filtered through a Chamberland filter six days later. 4 cc. of this filtrate were injected intravenously in a rabbit weighing 2,440 grammes (Chart II). No symptoms were produced

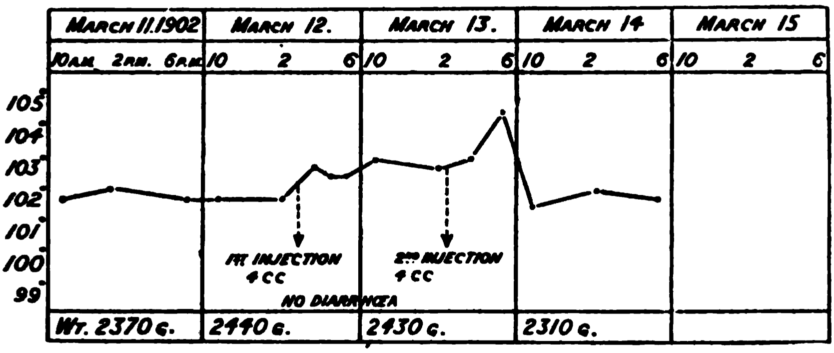

CHART II.—Intravenous injection in rabbit of two doses (each 4 cc.) of filtrate of an 18 days' culture of the B. dysenteriæ in peptone broth (100 cc.) and sheep's serum (20 cc.).

on that day except a slight rise of body temperature. On the following day a similar dose was injected intravenously, producing a greater rise of body temperature than on the previous day, but no other symptoms. Subsequently the animal returned to the normal condition.

2. In another experiment the bacillus was grown in several flasks, each of which contained a mixture of 50 cc. of peptone broth, with 10 or 15 cc. of sterilised sheep serum. After 38 days' growth at 37° C., the flasks were found to contain a pure culture of the bacillus. The flasks were sterilised by chloroform, and subsequently filtered through a Chamberland filter. 4 cc. of the filtrate were injected intravenously into a rabbit weighing 1,510 grammes. The result during the first six hours was at first

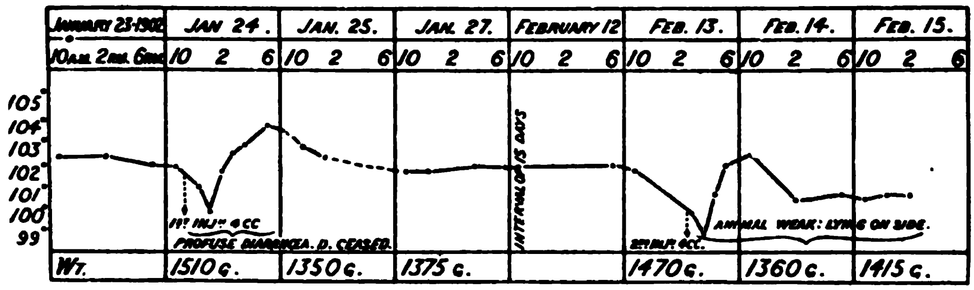

CHART III.—Intravenous injection of two doses (each 4 cc.) of filtrate of 38 days' culture of B. dysenteriæ in peptone broth (450 cc.) and sheep's serum (100 cc.).

a lowering of the body temperature of about two degrees, followed by a rise of two degrees above the normal, and this fluctuation of the temperature was accompanied by a profuse diarrhœa, with dark loose motions. The animal gradually regained its normal condition, both as regards weight and temperature. Subsequently, 20 days after the first injection, it received a second dose of 4 cc. intravenously. This caused a marked lowering of the body temperature, which persisted more or less during the next three days, the animal during this time being greatly weakened by the poison. It was then killed with chloroform. The post-mortem examination showed that the animal was somewhat thin, but that all the organs were healthy to the naked eye. The heart muscle was normal microscopically, and no degeneration was observed in several intramuscular branches of the right sciatic nerve which were examined. The blood obtained from the right ventricle was dark in colour and coagulated very slowly, taking over half an hour to form a firm clot. The serum reaction of the serum obtained from this blood clot with a 24 hours' culture of the bacillus showed, in a dilution of 1 in 100, well marked agglutination in five minutes, which, however, was not complete in 10 minutes.

3. It was necessary to determine whether the poisonous quality of the filtrate of the growth of the bacillus in broth and serum was due to any non-proteid body which would be present in the alcoholic extract. About 500 cc., therefore, of a broth and serum culture of the bacillus 38 days old was after filtration through a Chamberland filter, evaporated to dryness *in vacuo* at 36° C.; the dark brown residue was re-dissolved in water, precipitated by absolute alcohol, and filtered in a few minutes. The filtrate was next dried at 37° C., dissolved in alcohol, filtered, and again dried and redissolved in alcohol and filtered. A final residue, which was completely soluble in absolute alcohol, was used for experiment.

A rabbit weighing 1,460 grammes was kept under observation for three weeks, the temperature varying between 102° and 102·6°,

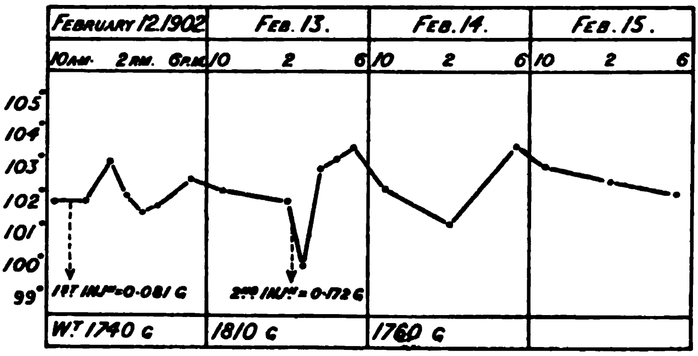

CHART IV.—Intravenous injection, in two doses (0·081 and 0·172 gramme = 0·071 gramme per kilo. of body weight), of alcoholic extract from a 38 days' culture of the B. dysenteriæ in broth and serum.

and the weight increasing to 1,740 grammes. It then received, intravenously, 0·081 gramme of the alcoholic extract, which was equal to 0·047 gramme per kilo of body weight. The animal showed no symptoms after the injection except a rise of one degree in temperature in two hours. On the following day it received an additional dose, intravenously, of 0·172 gramme, equal to 0·095 gramme per kilo. of body weight, the total dose per kilo. of body weight being 0·071 grammes. Half an hour after the second injection the temperature fell two degrees, but subsequently rose to one degree above the normal. On the following days the temperature regained the normal and the weight continued to increase.

No very poisonous body is therefore present in the alcoholic extract; that is, the poisonous effect of the filtrate of a growth of the bacillus is not due to a non-proteid body.

4. *The Toxicity of the Bodies of the Bacillus.*—The bodies of the bacillus were obtained from the broth and serum cultures after 38 days' incubation. The bacillus was killed by the addition of chloroform, and when tested after seven days gave no growth. The liquid was then centrifugalised and the supernatant liquid poured off from the residue. This was then stirred up with distilled water and again centrifugalised. The water poured off left a creamy white deposit consisting solely of the bodies of the bacillus, which when examined microscopically were partly intact and partly ruptured. The deposit was dried *in vacuo* over sulphuric acid and ground into a powder, which was yellowish brown. The total amount obtained was 0·62 gramme. This powder, mixed with sterilised distilled water, was used for experiment.

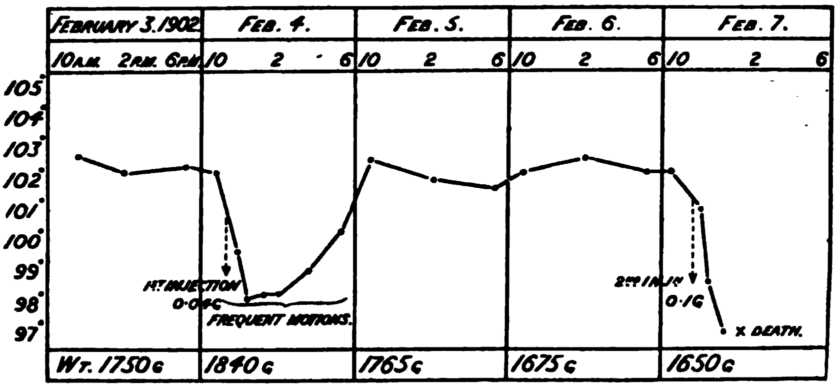

Chart V.—Intravenous injection, in two doses (0·04 gramme and 0·1 gramme = 0·043 gramme per kilo. of body weight), of the dried and powdered bodies of the B. dysenteriæ.

A rabbit weighing 1,840 grammes received, intravenously, 0·049 gramme of the powder, equal to 0·026 gramme per kilo. of body weight. As shown in the chart, within 40 minutes the

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temperature had fallen to nearly three degrees below the normal, and the subnormal temperature lasted for the seven hours of observation during that day. At the same time as the subnormal temperature there was a frequent passage of the contents of the intestine, which were apparently not altered in character. On the following days the animal had regained its normal temperature, but its weight continued to decrease. Three days after the first inoculation a second dose of 0·1 gramme was given intravenously, equal to 0·06 gramme per kilo. of body weight, the total dose per kilo. of body weight being 0·043 gramme. In half an hour the temperature had fallen over a degree; in an hour and a half it had fallen over three degrees; in two and a half hours over five degrees; and death occurred in three hours. Examination after death showed the animal to be fat and well nourished. The heart showed no abnormal signs, and the lungs showed, in the substance and near the surface, very numerous dark-red patches, which microscopically proved to be patches of deep congestion, with some hæmorrhage. No doubt these petechiæ and patches of congestion were due to the undissolved powder of the bodies of the bacillus. The stomach was full of food, and the small intestine contained a moderate amount of clear fluid. The cæcum was full and the rectum contained fæcal masses. No abnormal signs were observed in the spleen or liver.

It was quite obvious from this experiment that the most potent poison of the bacillus is present in the bodies of the bacteria. The great lowering of body temperature in the rabbit which results from its intravenous injection and the rapid death show this. The action, however, of the bodies of the bacillus is but an exaggeration of the action of the soluble poison present in the filtrate of the cultures of the bacillus.

Products of the Proteus Vulgaris.

A few experiments were done with this "putrefactive" bacterium on the same lines as those with the bacillus of dysentery, in order to contrast their action.

The proteus vulgaris shows, microscopically, narrow rods, which vary considerably as regards their length; they are actively motile, with numerous flagella. It stains by Gram's method, and grows both aërobically and anaërobically. Its growth is very rapid. It liquefies gelatin, coagulates milk, and grows sparingly on potato. It causes putrefactive decomposition of proteids, with the formation of foul-smelling bodies—carbonic acid, hydrogen, and indol. It decomposes urea into ammonium carbonate, and produces from proteids poisonous bodies, Schmiedeberg's "sepsin" being a solution of these substances. Choline, ethylenediamine, gadinin, and trimethylamine have been described as products of the action of proteus on proteids.

It is found in decomposing meat and other substances, in stinking water, and is present in the air. In the healthy body it is found in the intestine; and in disease it is found in foul ulcers, in the urine in cystitis (sometimes associated with the bacillus

coli communis); and to its action has been ascribed the stinking motions of the diarrhœa of children. Some forms of meat poisoning have been ascribed to its action.

Subcutaneously injected into rabbits it produces a foul abscess, especially when mixed with streptococcus. The toxic action of the bacillus is described as an intoxication of the body and not an infection.

An infection of the body has, however, been described in man, following a general peritonitis from intestinal infection. The proteus was found in the blood, the spleen, the liver, and proved highly virulent to mice, guinea-pigs, and rabbits. (Grossmann: Abstract in Cb. f. Bakteriologie, Vol. XXXI., p. 34, 1902.)

The culture of proteus used for experiment was an ordinary laboratory one, which showed all the characteristic reactions of the micro-organism. It was grown for 20 days in 200 cc. of peptone broth, to which 40 cc. of sterilised sheep serum were added. This produced putrefactive decomposition, and the filtrate through a Chamberland filter was foul smelling. The results of the intravenous injection of this filtrate in a rabbit, are given in the accompanying chart (VI.):—

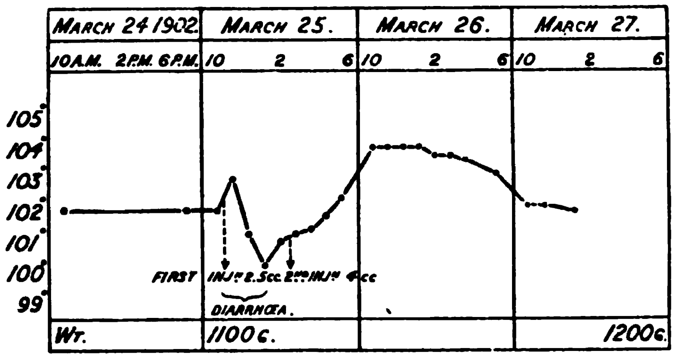

Chart VI.—Intravenous injection, in two doses (2·5 cc. and 4 cc.), of filtrate of growth for 20 days of proteus vulgaris in broth (200 cc.) and serum (40 cc.)

In a rabbit weighing 1,100 grammes 2·5 cc. of the filtrate were injected intravenously. In half an hour the temperature rose one degree, but subsequently fell nearly two degrees, and during this period there was diarrhœa. Four hours after the first injection 4 cc. of the filtrate were injected intraveneously. No appreciable result followed on the same day, but during the whole of the following day the temperature remained considerably above the normal. On the next day it fell to normal, and no further change was observed in the animal.

The experiments are being continued.

No. 3.

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On the Differentiation of the several Anaërobic Microbes commonly present in the Intestinal contents of Man and other Animals; by Dr. Klein, F.R.S.

REPORT on the DIFFERENTIATION of the several ANAËROBIC MICROBES commonly present in the INTESTINAL CONTENTS of MAN and other ANIMALS; by Dr. E. KLEIN, F.R.S.

(*Plate I.; Figures* 1—5.)

In several papers published in the Reports of the Medical Officer (1895–1896; 1897–1898; 1898–1899) I have given an account of life history, cultural characters, distribution, and physiological action of the obligatory anaërobe which I have named "bacillus enteritidis sporogenes."

It was shown in the above reports that the spores of this microbe are constantly present in fæcal matter, in sewage, manure, street dust, polluted water, milk, &c., and that therefore they may be found in solids and fluids to which directly or indirectly such filth has had access. It was shewn also that by the milk test this microbe can be readily recognised. The suspected material is placed in recently boiled sterile milk within a test tube, this is then kept heated for 10–15 minutes at 80°C., whereby all microbes except spores are killed. The milk is then cooled and incubated in a Buchner tube under anaërobic conditions brought about by employment of pyrogallic acid and liquor potassae.

It is to be observed however, that the inoculated and heated milk tube, if it contains the spores of B. enteritidis, may undergo the change typical of the growth and multiplication of bacillus enteritidis notwithstanding that it is *not* incubated in a Buchner tube.

From this it has been concluded that the bacillus enteritidis sporogenes must be capable of growing aërobically. Such a conclusion is however quite wrong; because the milk being covered with a layer of cream is practically anaërobic provided the air in it has been driven out by previous boiling. That the B. enteritidis is an obligatory anaërobe, and that the above is the true explanation of its seeming aërobic growth, can be shown by the following two simple experiments:—

(*a*) Take a sterile milk tube, shake it well up with air so as to thoroughly aerate the milk, and inoculate the tube from an actively growing pure culture of B. enteritidis: Then incubate the milk tube anaërobically. Result: either no growth or very scanty and very retarded growth.

(*b*) From a typically changed milk culture of B. enteritidis (in which growth has occurred without Buchner tube) inoculate the surface of agar or gelatine set in a test tube with slanting surface, or the surface of agar or gelatine set in a plate. The inoculation should be made with several drops of the milk teeming with

bacillus enteritidis. Incubate in ordinary fashion the tubes and plates (agar at 37°C., gelatine at 20–21°C). The result is nil ; no growth of B. enteritidis.

The absolute inability of B. enteritidis to show growth when placed *on the surface of solid media and incubated aërobically*, and conversely the copious growth of it on the surface of the same media kept anaërobically, conclusively proves that it is an obligatory anaërobic microbe.

I have repeatedly pointed out that the demonstration of this microbe by the milk test is one of the easiest and simplest of procedures, and Dr. Houston and I have demonstrated the numerical abundance of its spores in sewage and in water naturally or experimentally polluted with sewage.

In various reports issued by the Thompson-Yates laboratory (Vol. III., 1 and 2) it has been shewn that a number of articles (foodstuffs, strawberries, dust, grain, &c.) contain the spores of B. enteritidis. This was of course to be expected seeing that these articles are exposed to contamination with earth, street and other dust, etc., which substances I had already shown contain the spores of this microbe. How its presence in such polluted articles could affect the question whether or no the bacillus enteritidis when ingested under certain at present unknown conditions could cause diarrhœa in human beings, is not quite clear.

One might as well say that because a large number of people have diplococcus pneumoniæ in their saliva and in their bronchi, the diplococcus pneumoniæ cannot have concern in croupous pneumonia, endocarditis, meningitis, peritonitis, otitis media, &c., of which it has been held to be a cause ; or, seeing that the B. coli is an ubiquitous microbe and normally present in the human body, this micro-organism cannot be a microbe causing cystitis, choleraic diarrhœa, &c., &c.

The microbe (B. enteritidis sporogenes) has been proved to be capable of causing severe inflammation and copious exudation—nay, even gangrenous changes—in connective and muscular tissues when multiplying therein, and it has also been shown that in several outbreaks of diarrhœa severe intestinal inflammation with hæmorrhage was associated with the copious presence of the microbe in the small intestine (the mucous flakes in some instances being found crowded with the microbe). The question therefore arises ; under what conditions does such a copious multiplication of the microbe *in the small intestine* with ensuing pathogenic effects occur ? and further, what are the special conditions under which a microbe more or less ubiquitous and apparently under ordinary conditions harmless, becomes endowed with the power of causing particular and specific pathogenic processes ?

On account of the readiness and ease with which the *presence* of B enteritidis sporogenes can be demonstrated by the milk test, Dr. Houston and I have in a series of papers (Report 1895–1896 ; Report 1897–1898, p. 318) shown the importance of this milk test for demonstrating pollution of water with surface microbes (from sewage, manure, &c.). This milk test I, as also Dr. Houston,

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employ constantly in analysis of water, &c. It must be obvious that owing to the wide distribution of the spores of B. enteritidis in earth, in street dust, and in filth of all kinds, the *number of spores* in a given quantity of water, mud, &c., is all important. While for instance 1 spore in 500 c.c. of a water may mean nothing obnoxious, the presence of 10 spores in 100 c.c., may and generally does mean an admixture of undesirable matter, *e.g.*, an undesirable quantity of filth; and for this reason B. enteritidis as also B. coli is an important index in judging of the relative purity of a given substance.

With reference to the question of *pathogenicity* of B. enteritidis, I have in my previous reports on this microbe repeatedly pointed out that according as it is derived from different sources the microbe presents different degrees of virulence, as judged by its effects on the guinea-pig. Thus, I mention (Report 1897–1898, p. 210) the extremely high virulence of the spores of this microbe derived from Hendon sewage as contrasted with the lesser virulence of similar spores from cases of diarrhœa and from typhoid stools. Typical milk cultures of this microbe from Hendon sewage, when used in subcutaneous doses of 0·5 c.c., killed (producing extensive gas and sanguineous exudation in groin and abdomen) a guinea-pig of 200–300 grammes within 24 hours; whereas equally typical milk cultures of the microbe from some typhoid stools subcutaneously injected in doses of 1 c.c. or even 2 c.c. into guinea-pigs weighing each 200–300 grammes, caused merely temporary gelatinous tumour which healed after ulceration in a short while.

A curious seeming variation in virulence of B. enteritidis which has been repeatedly observed by myself and by Dr. Houston in our joint work (Reports 1897 and 1900), and which has been repeatedly shown to me by my colleague Dr. Houston in his separate investigation on sewage, is this:— If a series of anaërobic milk cultures be made of a particular sample of sewage, the several cultures differing from one another only in the amount of sewage added, these cultures may on incubation exhibit different degrees of virulence. It generally happens that while all the tubes change typically sooner or later, the whey of those inoculated with the greatest amount of sewage acts more virulently than the whey of the tubes that received lesser amounts; in the tube indeed that received the smallest amount virulence may be altogether absent. I merely record here the fact; later I will offer an explanation of this curious phenomenon, after considering more fully the microbes that are generally associated with the B. enteritidis sporogenes.

Bacillus Enteritidis and Bacillus Butyricus.

In my report for 1898, I have pointed out that some samples of milk bought in a London retail shop contained, besides spores of the pathogenic B. enteritidis, spores of the anaërobic non-pathogenic B. butyricus of Botkin. I have since ascertained, in confirmation of Botkin's observations, the occurrence of the spores of this latter microbe under many other conditions and in materials

more or less associated with, or polluted by filth of various kinds. As I have shown the two microbes B. enteritidis sporogenes and B. butyricus of Botkin—both being obligatory anaërobes—resemble each other in morphological and some cultural respects so strikingly that from these characters alone no diagnosis can be made, and that the only difference thus far ascertained is expressed in the fact that B. enteritidis sporogenes is pathogenic whereas B. butyricus is without any such physiological action.

But while this physiological distinction between the two microbes is very striking, occasions may occur when B. enteritidis is so attenuated in its virulence that 1 c.c. of its milk culture would not cause any but a slight temporary effect on the guinea-pig ; an effect which might be altogether overlooked and thus cause identification of the microbe with B. butyricus.

Owing to these and other facts, I have submitted the two microbes to an extensive study as regards their cultural characters, and am now able to indicate certain phenomena by which a distinction between the two microbes by culture alone can readily be made.

As already mentioned the spores of the two microbes are often associated in filth of various kinds, as for instance sewage and manure. They are notably present too in intestinal discharges of man and animals. Also I have shown (Report 1898–1899, p. 344) that another sporing anaërobe is of normal occurrence in the intestine of man and animals, and that this other microbe is a principal instrument in the disintegration and dissolution of the viscera of the dead body. This microbe I have described as B. cadaveris sporogenes. It is then association of the spores of these three anaërobes with which in the bacterioscopic examination of filth, or of materials polluted with filth and dust, we are constantly confronted a circumstance which might, to the uninitiated, make correct diagnosis a matter of great difficulty and lead easily to error, as I shall have opportunity to show.

For these reasons an accurate study of these three microbes in their morphological, cultural, and physiological characters is a desideratum, and it is the result of the study of these characters which I proceed here to describe.

I. The bacillus enteritidis sporogenes and the bacillus butyricus of Botkin are both obligatory anaërobes, cylindrical in shape measuring on average 2·5 to 3·5 μ in length, 0·8 to 12·5 μ in thickness ; their ends are slightly rounded, and in certain cultures they form chains of cylindrical bacilli. In cultures of some standing, the bacillus butyricus forms long threads, twisted and convoluted (*see* below) ; this is not observed in the cultures of B. enteritidis. Both microbes stain well by Gram's method.

Stained for flagella, they both show several long filaments chiefly at one end ; bacillus enteritidis more than the B. butyricus shows a bundle of them projecting at one end.

When examined in the hanging drop from a recent culture (*e.g.*, milk or agar) neither bacilli show locomotion ; but taken from

animal tissues many of them are seen to be distinctly motile. To obtain the bacilli from animal tissue is simple enough in the case of B. enteritidis; for the microbe being of a pathogenic nature it multiplies in the subcutaneous tissue of the guinea-pig, and thereby causes profound changes and death, the sanguineous copious exudation being crowded with the bacilli; a drop of the exudation fluid diluted with salt solution and examined in the hanging drop shows some motile forms. But in the case of the non-pathogenic B. butyricus it is also possible to cause a rapid multiplication of the bacilli in the animal tissue, by intravenous or by intrathoracic injection of a guinea-pig with a culture of B. butyricus, and immediately afterwards killing the animal and incubating it for 24 hours. The bacilli obtained from such an animal examined in the hanging drop show often distinct motility.

II. Both microbes form under certain conditions oval highly resisting spores. In their fully developed condition these are oval about 1·6 μ long, 1 μ broad. They stain after the usual method of spore staining—boiling fuchsin, well washing in water, then counter-staining in methylblue. In both microbes the spores are formed in the middle part of the individual bacilli, in some examples a little excentric, *i.e.*, a little nearer to one end. But the central position is the more common. Since the fully developed spore is in its broad diameter thicker than the average bacillus, it follows that where the bacillary substance is still present, the spores seem to form a bulging-out of the middle part of the bacillus.

The demonstration of these microbes B. enteritidis and B. butyricus was, as has been repeatedly mentioned, effected by placing the matter suspected of containing the spores in milk, heating this milk to 80° C. for 10–15 minutes, and then incubating it. By this heating to 80° C. all micro-organisims except spores are destroyed, so that the growth resulting on incubation must therefore be derived from undestroyed spores. If such milk *on incubation at 37° C. changes in 24–48 hours* in the fashion that I have described (*see also* below) as the *typical change*, it may be taken for granted that the milk has been infected with either the spores of B. enteritidis or of B. butyricus, or of both. This positive experiment of milk cultivation presupposes then the existence of spore formation in the two microbes. While this spore formation may be taken as fully established it is however a matter of difficulty to show it by cultivation. I have already in a former report shown that in the case of B. enteritidis no spores are formed in the bacilli in milk culture or in or on agar culture, be this a streak or a stab culture, be it in ordinary or glucose agar, be it incubated at 20° C. or at 37° C. Never have I observed spore formation to take place in these media, and I mention here the further fact that also in the case of B. butyricus no spores are observed either in milk or in agarcultures.* With regard to

* It is necessary to insist on the fact that B. enteritidis sporogenes *does not* form spore-bearing bacilli in milk culture, for the reason that the presence of spore-bearing bacilli in anaërobic milk culture of oysters has been erroneously held to denote that the molluscs in question had contained B. enteritidis sporogenes.

On the Differentiation of the several Anaërobic Microbes commonly present in the Intestinal contents of Man and other Animals; by Dr. Klein, F.R.S.

ordinary nutrient gelatine and sugar gelatine I have corrected in my report for 1900 the mistake made in 1898 as to spore formation. I have since found that the spores formed in the cultures in this medium were not those of B. enteritidis, but were those of B. cadaveris sporogenes.

Summarising then thus far, no spores are observed to be formed either of B. enteritidis sporogenes or of B. butyricus in the laboratory in milk—agar—or gelatine cultures.

I described in 1897-1898 the formation of spores in B. enteritidis when that microbe is grown on solidified blood serum. This I have repeatedly observed and I have kept such spores in a living and active state for many months. The growth gradually and slowly liquifies the serum. I have, however, seen many serum cultures in which, although they gradually became liquified, the bacilli did not form spores; and I am unable to explain why in some serum tubes (slantingly solidified) copious spore formation takes place while in others the spores are absent. For these reasons I have for some years had recourse to another method for the formation and preservation of spores of B. enteritidis, and this method I have described in my report for 1897-1898, p. 217.*

It is this: The subcutaneous sanguineous exudation, which is always copious if death takes place within 24–30 hours, is drawn up into capillary pipettes. These are then sealed in such manner as to have as little air as possible at the ends, and are then placed in the incubator at 37° C. An equally good if not better plan is to place the fluid by means of a sterile pipette into a sterile test tube plugged with sterile wool, and then to incubate this anaërobically in a Buchner tube at 37° C. After about a week copious free spores will be found in the malodorous fluid.†

Another method for obtaining spores is this: Of a recent culture (milk, agar, or gelatine) a fair amount is injected, immediately after death of the animal, through an intercostal space into the thoracic cavity of a guinea-pig or rabbit. The animal is then kept in the incubator at 37° C. for 24 hours. After this interval the chest will be found greatly blown out, the subcutaneous tissue of the chest, neck, and axilla appearing like a sponge full of gas. On opening the chest there is found great discoloration of the viscera with abundant sanguineous malodorous fluid; and in this fluid are crowds of the B. enteritidis, many motile, and some containing more or less fully developed spores in the *middle portion* of the rods. This fluid, sealed in capillary pipettes and incubated at 37° C. for a day or two, shows crowds of fully developed free spores.

* This method I described also in the Centralblatt f. Bakteriologie, Vol. XXII., 1897, p. 580.

† It is curious therefore to find, some years later than my description of my method in the Centralblatt f. Bakteriologie (Vol. XXII., 1897, p. 580), a reference, by Dr. Rist of Paris (Centralblatt f. Bakteriologie, &c., Vol. XXX., No. 7, p. 287), advocacy by Veillon and Lubet of the same method of transferring the exudation (caused by a microbe evidently the same as B. enteritidis though described under the name of bacillus perfringens) into capillary pipettes and sealing them in order to obtain spores.

As has been repeatedly pointed out sewage, manure, and street dust always contains the spores of B. enteritidis, and for this reason I thought the admixture of urine or sewage to gelatine or agar might be useful in enabling the B. enteritidis to form spores. In ordinary gelatine, sugar gelatine, ordinary agar, or sugar agar neither the B. enteritidis nor the B. butyricus are in my experience ever capable of forming spores. But when the gelatine and the agar have urine or sewage added to them the conditions become entirely changed. The urine-gelatine and urine-agar, sewage-gelatine and sewage-agar are prepared like nutritive gelatine and nutritive agar with the difference that instead of dissolving the gelatine or agar in beef broth it is dissolved in filtered urine or in filtered sewage, 1 per cent. peptone and 0·5 per cent. sodium chloride being added as with the ordinary media. The general method of heating, making alkaline, filtering and sterilizing is carried out as usual. The B. enteritidis grows well in urine-gelatine and urine-agar, less copious in the sewage-gelatine and sewage-agar. Spores make their appearance (oval spores situated in the middle of the bacilli) after a week, and their number steadily increases though even after many weeks they are not very abundant. Nevertheless the spores are unmistakeably present in sufficient numbers to yield a dozen or so in every field of the microscope. The best results are obtained by incubating the urine-gelatine or sewage-gelatine—after inoculation with B. enteritidis—at 37° C. After some days or weeks a powdery or floccular grey sediment will be noticed, the rest of the (melted) gelatine being fairly clear. In the sediment and flocculi fairly numerous spores will be found; the bacilli are chiefly cylindrical, comparatively few chains and threads. In these cultures I have preserved spores, ready for experiment, many months.

I have also attempted to develop spores in B. enteritidis on pieces of muscle (of guinea-pigs) sterilised in the steam steriliser and kept in test tubes. After inoculation the tubes were kept anaërobically at 37° C. But no spores were developed.

Equally unsuccessful were attempts to form spores in the bacilli growing anaërobically in the eggs of fowls. The eggs were, after disinfecting the outer shell surface, inoculated through a hole drilled through the shell; this was then sealed up and the egg kept in a Buchner cylinder and placed in the incubator at 37° C. Although good growth and multiplication took place, the whole of the interior of the egg becoming reduced to a small mass of discoloured thick fluid, there were no spores formed within the bacilli.

A good deal of what has been said here of the positive and negative results of spore formation of B. enteritidis applies also to B. butyricus. To repeat: B. butyricus does not form spores in milk, gelatine, agar culture, or egg culture. B. butyricus forms spores in sewage-gelatine kept at 37° C. After some weeks, the spores are developed in the middle of the bacilli, many of which form long threads. No spores are developed in urine-gelatine, although the bacilli form threads of extreme length. Therefore,

the only medium in which I have hitherto been able artificially to grow spores in B. butyricus is sewage-gelatine kept at 37° C. for some weeks.

III. Cultivation of B. enteritidis and B. butyricus while revealing some striking similarities shows also characteristic differences.

In my former reports I have minutely described and illustrated the appearances of the colonies of B. enteritidis on agar and the typical change produced in milk, and I need not again dwell on these points except to mention that the bacillus butyricus, although forming colonies on agar of almost identical character,* viz., a rounded grey disc, which gradually thickens in the centre but remains thin and filmy in the periphery; as development proceeds and the colony enlarges the outline of the filmy peripheral part becomes irregular, knobbed and crenate and fan-shaped. In the case of the B. butyricus these irregularities and projections of the colonies are considerably more developed than in those of B. enteritidis kept under precisely the same conditions.

As regards stab cultures in agar and sugar-agar the two microbes are very similar; forming masses of colonies along the track of the needle and also forming copiously gas bubbles by which the agar is greatly expanded and torn. But there is this marked difference between the two microbes : B. butyricus shows large numbers, in fact continuous masses, of tufts of longer and shorter filaments extending under a right angle from the line of growth, whereas these tufts of filaments do not develop, or only in an imperfect way, in the case of B. enteritidis. I have found in a very considerable number of parallel stab cultures in ordinary nutrient agar and sugar agar that the difference just described is real and of diagnostic value.

But there is one difference between the two microbes which is easily demonstrated and which is very striking. This is the difference presented by the two microbes in streak culture on the slanting surface of ordinary nutrient gelatine, and also of glucose gelatine, incubated anaërobically at 20–21° C. This difference is shown in Figs. 1 and 2, Plate I., which represent cultures of B. enteritidis (Fig. 1) and of B. butyricus (Fig. 2) in several streaks on the slanting surface of ordinary nutrient gelatine; the cultures having been incubated anaërobically (in Buchner tube) at 20–21° C. for 8 days. Inspecting Fig. 2 (B. butyricus) with a glass, streaks of flat growth—grey translucent—will be noticed composed of masses of convoluted threads with no trace of liquefaction. In Fig. 1 (B. enteritidis) on the other hand the growth is indicated by whitish grey masses and granules softening and liquefying the gelatine. As time goes on this liquefaction slowly but gradually becomes more and more pronounced, whereas in B. butyricus (Fig. 2) the growth remains unaltered and does

* The statement by Prof. Stewart of Liverpool (Vol. III., p. 31, Thompson Yates laboratory) is to me absolutely incomprehensible, in that the B. enteritidis grows on agar and other solid media only with great difficulty.

not cause any trace of liquefaction even after weeks and months.

The difference is still more strikingly shown in stab culture in urine-gelatine. Figs. 4 and 5, Plate I., show this: Fig. 4 is a stab culture of B. enteritidis in urine-gelatine incubated anaërobically at 20–21° C. for eight days. It shows slight softening of the gelatine along the growth but no filamentary out-growths. Fig. 5 on the other hand, which is B. butyricus kept under precisely the same conditions, shows no trace of liquefaction but large numbers of longer or shorter filaments projecting under a right angle from the stab.

While in the stab culture of B. enteritidis in ordinary and sugar gelatine liquefaction proceeds slowly but distinctly, there is no sign of liquefaction in similar culture in the case of B. butyricus. I wish to emphasise this difference in the present with a view to returning to it when dealing with certain experiments in the rabbit.

IV. *Experiments.*—It has been repeatedly mentioned that while B. enteritidis sporogenes is pathogenic for guinea-pigs (*see* my report, 1897–1898, p. 210), B. butyricus is without any such action. This difference is of an important character, inasmuch as milk is changed by both microbes in an identical manner and therefore a milk culture which on incubation at 37° C. shows the typical change might contain a growth of B. enteritidis or of B. butyricus, or of both. As a matter of fact sewage and many other filth materials contain the spores of both microbes. Sewage contains the spores of B. butyricus as a rule more abundantly than those of B. enteritidis, and this is the reason why milk cultures fail to show pathogenic action or show it imperfectly if they are started with small amounts of sewage. In order to more accurately explain this I will take a case in point: A series of milk tubes (recently boiled milk) are infected with varying amounts of sewage, (1) 1/100th, (2) 1/50th, (3) 1/10th, (4) 1/5th of a cc. They are next exposed to 80° C. for 10–15 minutes, are then cooled and put in Buchner's cylinder and incubated at 37° C. Next day or the day after, all the tubes are typically changed: the layer of cream is torn and disturbed by much gas, pinkish casein flocculi appear on the top and here and there at the side of the tube, at the bottom are casein coagula, and there is a copious amount of more or less turbid whey. On opening the tubes, the changed milk has a distinct smell of butyric acid, the whey has definite acid reaction and is crowded with the typical bacilli. A series of four guinea-pigs of equal size are now injected with whey of the cultures, each animal receiving about 1 cc.; guinea-pig No. 1 is injected from the 1/100 cc. tube; guinea-pig No. 2 from the 1/50 cc. tube; guinea-pig No. 3 from the 1/10 cc. tube; and guinea-pig No. 4 from the 1/5 cc. tube. Next day guinea-pig No. 1 will be found either unaffected or with only very slight tumour; guinea-pig No. 2 will be found affected with a fair sized gelataneous swelling; guinea-pig No. 3 and guinea-pig No. 4 most probably, but guinea-pig No. 4 almost certainly will be found dead. The skin of the groin and

abdomen of the dead animals will be found separated by an interval from the subjacent subcutaneous and muscular tissues, which are in shreds and partly dissolved; there is also much gangrenous exudation crowded with the cylindrical shorter or longer bacilli. Now the explanation which I offer for this apparently different pathogenic action of the milk after infection with different amounts of sewage is this: Dr. Houston and myself (Report of Local Government Board) have shown that the number of spores of B. enteritidis in domestic sewage varies between about 100 and 2000 per cubic centimetre. Assuming that the number of spores of B. butyricus be larger than those of B. enteritidis, and knowing that both develop equally rapidly in milk at 37° C., the typically changed milk will in the case of tube No. 1 contain many more B. butyricus than B. enteritidis, and the pathogenic action of its whey will, since it contains few B. enteritidis, be practically nil; whereas, in the case of tubes No. 3 and particularly No. 4, the milk will contain a sufficient number of B. enteritidis to be virulent, *i.e.*, fatal in 1 cc. dose to the guinea-pig.

The separation from such a typically changed milk culture of the B. butyricus and B. enteritidis by subculture is not a difficult matter if the whey is diluted and with this dilution anaërobic culture is made on the slanting surface of gelatine in tubes or on the surface of gelatine set in a plate dish. It will have to be remembered that the colonies of B. enteritidis show soon a softening and commencing liquefaction, whereas those of B. butyricus are made up of thready convolutions and are non-liquefying. Of course the best method is the animal experiment, because in the case of pathogenic action the exudation contains principally the B. (enteritidis) sporogenes, and by making a dilution of this exudation the sub-cultures yield at once the colonies of B. enteritidis sporogenes.

Both B. butyricus and B. enteritidis multiply rapidly in dead animal tissues, particularly when kept at 37° C. Following therefore the method first described by Welch and Nuttall (John Hopkin's Hospital Bulletin No. 24, 1892), a little of the whey of a typical milk culture of either B. butyricus or B. enteritidis, or of an emulsion of a living (recent) agar or gelatine culture of either microbe, may be injected into the ear vein of a rabbit, and the animal killed immediately after (1–5 minutes) by instantaneous destruction of the medulla oblongata. The dead bodies of the animals should then be placed in the incubator at 37° C. Next day the bodies of the animals will be found tremendously blown out; the abdomen tense and like a drum, the limbs full of gas and feeling like sponges, as also the tissues of the chest wall and axilla and neck and head. Cavities with gas will be found in the inguinal, cubital, axillary and cervical region. On opening the abdominal cavity much gas will be found in the viscera; the chest is much distended and the intercostal spaces almost as if blown away; the lungs enormously distended by minute gas bubbles, the diaphragm torn into shreds. The fact of the matter is the injected bacilli have been distributed into all parts by the blood stream and have multiplied greatly, and, as is also seen in culture

(milk, agar, gelatine), have in their multiplication caused great evolution of gas. In conformity with this, making anaërobic cultures from any tissue (subcutaneous tissues, heart, liver, lung), the microbe B. butyricus or B. enteritidis respectively will be readily recovered.

I have made several series of these experiments, and it seems to me that the B. enteritidis causes a little more rapid and a little greater evolution of gas, than the B. butyricus. But it must be distinctly understood that B. butyricus alone causes all the above changes in a striking manner. It follows from these experiments that by this method (Welch, Nuttall) a differentiation between gas producing anaërobes of different species cannot be made. I shall presently have occasion to return to this point after some further experiments now to be described.

Besides the above experiments of intravenous injections into the rabbit, I made the following experiments on the guinea-pig, Guinea-pigs are killed by chloroform inhalation, and after death cultures of B. butyricus and B. enteritidis are injected into the thorax of different guinea-pigs by means of a Pravaz syringe, the point of the needle of which is pushed through the intercostal muscle. Each animal is then placed in the incubator at 37° C. for 24 hours. Next day the subcutaneous tissue of the chest, axilla, and neck are enormously emphysematous and like a sponge; this is evidently due to some bacilli having been introduced (on inserting or withdrawing the needle) into the skin and subcutaneous tissue at the point of injection. Microscopic specimens, as also cultures, of the subcutaneous tissue show that a copious multiplication of the bacilli has taken place during the 24 hours. On opening the thorax cavity it is found that the heart and lungs are much discoloured and shrunk to very small dimensions, and that the muscles of the chest walls are much discoloured; in the thorax cavity there is more or less sanguineous fluid. This fluid is densely crowded with the bacilli, many of them motile. In the case of the dead guinea-pig injected with B. enteritidis, many of the bacilli contain an oval spore in the middle portion, whereas in the case of the B. butyricus guinea-pig, the bacilli are quite without spores. In both sets of experiments, however, there are present some sporing bacilli which from their morphological character (drum sticks and rapidly motile), as also by culture, can be recognised as the B. cadaveris sporogenes.

These experiments furnish further confirmation that when cultivated in the dead body of the rodent both microbes, B. butyricus and B. enteritidis sporogenes, form copious growth, much gas, and effect idential changes, and that on these grounds alone they cannot be differentiated. I may add here further that by similar cultivation in the dead body of the B. cadaveris sporogenes similar emphysematous condition in the subcutaneous and muscular tissue and viscera can be obtained, with the difference however that the results are not so conspicuous as, and that they set in somewhat later than in the case of the former two microbes.

Bacillus cadaveris sporogenes.

In my report on bacillus cadaveris (Report of the Medical Officer of the Local Government Board 1898–1899, p. 344) I have described this anaërobic microbe as derived from the intestine, and as playing after death, by its rapid growth into and through the abdominal and the thoracic viscera and further into the muscular tissues, a great part in reducing and destroying these tissues. The spores of this microbe are present in the contents of the alimentary canal of man and other animals; they are present in fæcal matter, in manure, street dust, sewage, and all similar filth; that is to say the spores of this anaërobe occur almost in the same materials in which the spores of B. butyricus and B. enteritidis sporogenes occur, and it is therefore important to be able to identify them and to distinguish one from the other.

The morphological and cultural characters of this B. cadaveris sporogenes are, as I described in a former report, sufficiently striking for differentiating this microbe from B. butyricus and from B. enteritidis sporogenes. They are:—

B. cadaveris is conspicuously motile, cylindrical, longer and thinner than the other two, forming in culture long filaments and threads; it stains well by Gram's method. It forms spores readily in all culture media. The spores are terminal, thus changing the bacilli into drum-stick-like forms, the swollen spherical to elliptical ends being due to the formation there of the spore. When fully developed the spore is oval, about 1·6 μ long, 1 μ broad; it stains by the ordinary method of spore-staining, viz., boiling fuchsin, then methylblue. It is an obligatory anaërobe and forms copious gas in all media; the cultures have a putrid odour. The B. cadaveris liquefies gelatine very rapidly. On the surface of agar it forms pale patchlike colonies with dark centre from which pass out numerous branched dark filaments. Some colonies show only the dark filamentous growth; in agar stab much gas, the stab showing very numerous lateral filaments. Milk at 37° C., is slowly decomposed, in the course of a week separating into a bottom layer of casein, a supernatant yellow coloured clear fluid, and a top layer of original cream; the culture has putrid odour and contains many sporing bacilli. B. cadaveris liquefies rapidly and grows well on solidified blood serum forming rapidly spores. It has no pathogenic action when injected subcutaneously into guinea-pigs. On account of its constant presence and association with the other two microbes in fæcal matter and similar filth, a milk culture made from such filth is liable to contain besides virulent B. enteritidis sporogenes also some of the bacilli of B. cadaveris sporogenes. It follows from this that if whey of this milk culture be injected into the subcutaneous tissue of a guinea-pig, and the animal be dead from it within 20 hours, the subcutaneous exudation of this animal examined next day would show also some bacilli cadaveris noticeable by their great motility and by their drum-stick forms. In further experiment, by culture and in preserving such fluid in sealed capillary pipettes

this possible admixture of B. cadaveris must not be lost sight of. For it may happen that sooner or later in the process of transferring the culture from tube to tube, a time may arrive when in the new culture only the B. cadaveris sporogenes is left, the B. enteritidis sporogenes having been completely gradually 'crowded out.' I myself fell some years ago into such error, viz., I regarded the virulent B. enteritidis sporogenes as gradually changing from a microbe which at first caused the butyric change of milk into a rapidly sporing, rapidly liquefying microbe, non-pathogenic and decomposing the milk. I soon learned, however, and have corrected, the original error (*see* Report 1900), viz., that the latter microbe is a different anaërobe, viz., B. cadaveris sporogenes, that has in the course of subculture gradually 'crowded out' the B. enteritidis sporogenes.

Bienstock described as B. putrificus coli drumstick forms of bacilli of the intestine which were stated to be aërobic in culture and to possess certain cultural characters in no way capable of being mistaken for the intestinal B. cadaveris sporogenes. But since the obligatory anaërobe B. cadaveris sporogenes has been described, B. putrificus coli has also become an obligatory anaërobe. From Dr. Bienstock's latest description of his microbe in the Annales de l'Institut Pasteur, Vol. XIII., p. 857, and Vol. XIV., p. 756, I have not the slightest doubt that this anaërobic B. putrificus coli is identical with B. cadaveris sporogenes. I have already in a former Report (1898–1899, p. 344) given good reasons for suspecting that the B. radiatus of Lüderitz (Zeitschrift f. Hygiene, Vol. V., p. 149) is the same microbe.

Bienstock has given satisfactory proof that his microbe rapidly decomposes and liquefies fibrin and plays an important rôle in putrid decomposition—facts which from the cultural characters above described are easily comprehensible. I have made the same series of experiments on the rabbit and guinea-pig as were described of the B. butyricus and B. enteritidis sporogenes, and as mentioned already, with the same result. But the gas production was slower and less in the case of B. cadaveris than with the other two microbes.

Remembering what has been said as to the wide distribution of these three anaërobes in filth, as to their different cultural characters, and as to their fairly similar action when experimented with after the Nuttall Welch method, it is easy to understand that the anaërobic microbes isolated from polluted wounds might belong to different species, *e.g.*, B. butyricus, B. enteritidis sporogenes, and B. cadaveris sporogenes. This is a supposition which I think harmonises with the numerous accounts given by Welch and Nuttall, and by Flexner, and with the numerous descriptions given by Welch's pupils, as to the cultural characters of Welch's "bacillus aërogenes capsulatus." The accounts given formerly and now suggest more than one species in wounds; at least B. butyricus and B. enteritidis sporogenes, but probably more than these two.

In conclusion I append a comprehensive tabular statement as to the essential differences between these three anaërobic microbes.

I. Bacillus Butyricus.	II. Bacillus Enteritidis Sporogenes.	III. Bacillus Cadaveris Sporogenes.
1. Cylindrical rods, on the average 2·5–3·5μ long, 0·8–1·25μ broad, stains well by Gram's method; some individuals motile.	1. Same as in I. ..	1. Cylindrical and thread-like, thinner and longer than I. and II., very motile, stains by Gram's method.
2. Spores oval, stain after the several methods, situated in the middle of the rods more or less, 1·6μ long, 1μ broad.	2. Same as in I. ..	2. Spores oval, terminal, drumsticks, stain after usual methods; 1·6μ long, 1μ broad.
3. Grows well on the surface of ordinary gelatine as a translucent mass of convoluted threads; does not liquefy the gelatine.	3. Softens rapidly the gelatine; slowly liquefying.	3. Rapidly liquefying, putrid odour, numerous spores formed.
4. In stab in gelatine forms spherical colonies with numerous horizontal filamentous projections; not liquefying, forms much gas.	4. Much gas, spherical colonies, without filamentous projections, slowly liquefying.	4. Much gas, rapidly liquefying, putrid odour.
5. On the surface of agar grey round flat colonies, margin thin and much crenate; no spores.	5. Same as in I., few crenations, no spores.	5. On the surface of agar forms thready branched colonies with or without finely granular plate; rapidly forming spores.
6. In stab in agar forms characteristic bundles of threads projecting laterally from the growth in the stab; much gas, no spores.	6. Little tendency for forming lateral branchings, much gas, no spores.	6. Much gas, rapidly forming spores, conspicuous masses of threads growing out of stab.
7. In milk rapid separation of acid whey and flocculi of casein; smell of butyric acid, no spores, much gas.	7. Same as in I. ..	7. Milk is slowly decomposed, putrid odour, much gas rapidly forming spores.
8. Grows well on serum, very slow softening.	8. Grows well, slowly liquefying; some spores formed.	8. Rapidly liquefying, putrid odour, rapidly forming spores.
9. Not pathogenic for rodents.	9. Virulent for rodents.	9. Not pathogenic for rodents.

No. 4.

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Bacillus Diphtheriæ and Micro-organisms liable to be confounded therewith; by Dr. Gordon.

REPORT on BACILLUS DIPHTHERIÆ AND MICRO-ORGANISMS LIABLE TO BE CONFOUNDED THEREWITH; by Dr. M. H. GORDON.

(*Plates VI.—XII.; Figures* 1—21.)

B. diphtheriæ, first isolated by Löffler in 1884, has for some years been recognised as the essential factor of diphtheria, so that at the present time it is by the presence of this micro-organism that the diphtheritic nature of incipient illness is with certainty detected. Experience, however, has shown that the identification of B. diphtheriæ is not such a simple matter as it at first promised to be. Owing to the occurrence in the throat and elsewhere of micro-organisms simulating B. diphtheriæ in one or more respects, but devoid of the same pathogenic significance, it is necessary to apply a series of tests to a given micro-organism before actual proof that it is a genuine example of the Klebs-Löffler bacillus can be considered to have been obtained. So frequently is the bacteriologist called upon to determine whether B. diphtheriæ is present or not in suspected cases that it is obvious that the differential value of the various characters by which the organism is recognised cannot be too thoroughly tested. Accordingly of recent years considerable attention has been given to the characters by which B. diphtheriæ can be distinguished from other micro-organisms with which it is likely to be confused. As a result of these researches the main characters by which B. diphtheriæ is identified are, briefly, four in number. First, the macroscopic and microscopic appearance of the growth on serum. Secondly, the behaviour of the suspected micro-organism to stains such as Löffler's methylene blue, Gram, and especially Neisser's stain for granules. Thirdly, the reaction shown to litmus by a subculture in neutral or slightly alkaline broth, containing 2 per cent. dextrose, after 48 hours at 37° C. Fourthly, the test of pathogenicity; *i.e.*, 1 cc. of a broth subculture of 48 hours' growth at 37° C. on subcutaneous injection into a guinea-pig weighing from 200–300 grammes produces in the great majority of cases death within 48 hours, whilst post-mortem, hæmorrhagic necrosis and œdema are found locally, the internal organs are congested, the pleural, pericardial, and peritoneal fluids are increased, and in particular the suprarenal capsules are enlarged and found on section to be engorged with blood. These four characters, viz., morphology, staining, acid-production, and pathogenicity, are generally sufficient to enable B. diphtheriæ to be identified. But if further proof is needed it is afforded by showing that the virulence of the organism, or of its toxin, is completely neutralised by a simultaneous dose of diphtheria anti-toxin.

In practice, however, it is not always possible to apply all these tests before giving an opinion. Too often a verdict is urgently required within 24 hours. Under these circumstances—and they are those under which by far the majority of the bacteriological diagnoses of diphtheria are at present carried out—it is from the microscopical appearance of the growth on serum, and from its staining reactions, that the conclusion is arrived at that in a given

material a micro-organism is present "morphologically indistinguishable" from B. diphtheriæ.*

Throughout the following observations on the subject of B. diphtheriæ and micro-organisms liable to be confused therewith this point has been kept in view; the chief consideration having been the bearing of the results on what may be termed the morphological differentiation of B. diphtheriæ. The procedure was as follows:—Cultivations on solidified blood-serum (horse's), supplemented in some cases by agar plate-cultures, were made of material from various sources in the human body, chiefly up to the present from the throats of patients suffering from diphtheria, but also from a few other sources, such as from the nasal discharge in cases of acute coryza and from the aural discharge in cases of scarlatina. Organisms resembling B. diphtheriæ, having been first isolated in pure culture, were then examined with special reference to the four characters—morphology, staining, acid-production, and pathogenicity for the guinea-pig. In the second place, an enquiry has been begun with the object of determining the applicability of the agglutination reaction for the purpose of distinguishing genuine B. diphtheriæ from other allied micro-organisms.

On this, as on previous occasions, I have to record my thanks to Dr. Andrewes for kindly supplying me with material. I have also to thank Mr. Brewerton for several cultures from the eye. I am especially indebted to Dr. McCombie, Medical Superintendent of the Brook Fever Hospital, and to Drs. Griffiths and Rolleston of that institution for their co-operation in giving me the opportunity of collecting material. Finally, I have to thank Sir Lauder Brunton for placing several cases at my disposal for bacteriological examination, and Dr. Scholberg for valuable aid.

The present state of knowledge concerning B. diphtheriæ and micro-organisms with which that microbe may be confused.

Before proceeding to describe the result of my investigations it is well to briefly review the present state of knowledge concerning B. diphtheriæ and its allies. A study of the literature shows that, while there is practical unanimity with regard to the characters of typical B. diphtheriæ, there has been in the past considerable difference of opinion as to the nature of the micro-organisms with which B. diphtheriæ is liable to be confused. Thanks, however, to the investigations of a number of observers the subject has latterly become clearer, so that at the present time three chief groups are distinguished. Group I. consists of organisms that fulfil all the requirements of genuine B. diphtheriæ, including morphology, staining, acid-production, and pathogenicity. On the other hand, the organisms belonging to the other two groups are not pathogenic to guinea-pigs. Group II. consists of organisms resembling B. diphtheriæ in morphology, staining, and in acid-production, and differing from that organism only in the fact that they possess

* Early and valuable evidence is obtained in a proportion of cases by direct microscopical examination of the material. The presence of bacilli morphologically resembling B. diphtheriæ, holding Gram, and showing Neisser's granules is strongly suggestive of diphtheria.

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no pathogenicity for the guinea-pig; hence organisms of this type are generally considered to be attenuated examples of the Klebs-Löffler bacillus. Group III. is composed of the bacillus of Hoffmann, a micro-organism that differs from B. diphtheriæ not only in being non-pathogenic for guinea-pigs, but also in morphology, staining, and in producing not acid, but alkali in dextrose broth. Over and above these three groups a further group has been described consisting of the so-called Xerosis bacillus. This organism, which occurs in the conjunctival sac both in health and disease, approaches genuine B. diphtheriæ in microscopical morphology more closely in some respects than does Hoffmann's bacillus, but differs macroscopically, does not stain with Neisser, does not produce an acid reaction in dextrose broth, and is quite devoid of pathogenicity for guinea-pigs.

The organisms with which B. diphtheriæ may be confused, therefore, appear to have one feature in common, namely, absence of pathogenicity for the guinea-pig, and may be subdivided into two groups according as they produce an acid reaction in dextrose broth or fail to do so.

But while the above distinctions between B. diphtheriæ and its non-pathogenic simulators have been described, there is a question of great importance and of no little difficulty, namely, the permanency or otherwise of such distinctions. Some investigators (Hewlett and Knight, Salter and Richmond) claim to have converted an example of Hoffmann's bacillus into a form indistinguishable from the genuine Klebs-Löffler bacillus by laboratory procedure, and have adduced evidence to show that similar modification of this bacillus outside the laboratory may be a possible factor in the spread of diphtheria. The work in this direction has recently been criticised in a valuable paper by Dr. Gordon Pugh in the medical supplement to the first annual report of the Hospitals Committee of the Metropolitan Asylums Board. I agree with him that before accepting the conclusion that B. Hoffmanni is convertible into B. diphtheriæ, and on this account is a factor in the causation and spread of diphtheria, more evidence is necessary, particularly with regard to the strict purity of the cultures used, and also with regard to the number of cases in which such a conversion may be considered to have occurred. Caution is particularly necessary when it is called to mind that the evidence at one time advanced in support of the conversion of B. anthracis into B. subtilis and at another of B. coli communis into B. typhosus has been in both cases discredited.

Arrangement followed in the present Report.

In describing the result of my investigation of diphtheroid micro-organisms isolated from various sources in the human body the subject has been subdivided into three main portions. In the first section have been placed all the micro-organisms met with that admit of identification with B. diphtheriæ owing to the fact that they possessed all the four chief attributes of that organism. In the second section have been placed all the organisms met with that did not possess the four chief attributes of B. diphtheriæ: these had one point in common, namely, absence of pathogenicity for the guinea-pig, and they ranged from an organism that differed

from B. diphtheriæ in the latter respect alone down to a form that could only be confused with it on a most superficial examination of a serum culture. In the third section the results of some agglutination experiments are described.

I.—Micro-organisms possessing all the Four Main Characters of B. Diphtheriæ, viz., Morphology, Staining, Acid-production, and Pathogenicity.

Altogether 18 micro-organisms have been isolated that were found on examination to fulfil all four chief requirements of B. diphtheriæ. They were obtained from the following sources :—from the throat either during or subsequent to an attack of diphtheria, 14; from a nasal discharge during diphtheria, 2; from an ear discharge in a case of scarlatina, 1; and (one example) from the eye in a case of membranous conjunctivitis.

The characters of these micro-organisms are as follows:—On solidified *blood-serum* (horse's) there is in all cases good growth. After 18 hours at 37° C. the colonies stand out from the surface of the medium as small, slightly-raised grey masses. In transmitted light they are seen to have a firm outline, homogeneous consistency, and often a faintly yellow or a faintly brown tinge. In the course of several days the colonies become larger and more raised, so that after four days the appearance is that seen in Fig. 1, Plate VI. Microscopical examination of film specimens of the 18 hours' growth on serum showed the same general result in all 18 specimens. The stain used was invariably Löffler's methylene blue. The appearance of such a film when viewed with a magnification of about 70 diameters depends a good deal on the amount of growth deposited on the cover-slip. In no case was coherency or conglomeration seen, though in all there was a tendency for the bacilli to form loose clusters. On increasing the magnification to 500 diameters the individual bacilli are clearly seen. It will be noticed that two are often arranged in lateral apposition, and at some places they are in polar apposition as well. A further point seen with this power is that the bodies are irregularly stained. With a magnification of 800 to 1000 diameters the characteristic morphology of B. diphtheriæ is brought into view. The individuals are irregularly stained rods, always with pointed or rounded ends. A few may show slight swelling at one end, but this is uncommon in young serum cultures. In specimens stained with Löffler's methylene blue the ends though clearly perceptible, are often shadowy, the stain being much better taken up towards the middle of the bacillus. Some of the rods here and there may be beaded and others may present a segmented appearance owing to more deeply stained portions alternating with others showing little or no staining. Polar granules are seen at places, and they may be of a red colour (metachromatism).

The examples of the diphtheria bacillus that I have isolated have been almost without exception initially of the short type. When grown on serum for 18 hours at 37° C. and stained with Löffler's methylene blue the shortest had an average length of only 1·7 μ. This would appear to be exceptionally low: after culture on artificial media for some time, or after passage through a

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guinea-pig, the length was in some few cases noticed to have increased. The length appeared to depend to some extent on the medium, and was as a rule greater on agar than on serum. A possible explanation is that, serum being the more favourable soil, division occurs there more quickly than on agar.

All 18 specimens of the diphtheria bacillus were subjected to *Neisser's stain*, and in all the characteristic granules were thereby demonstrated. The granules are most often situated at both poles, but not infrequently a granule occurs elsewhere than at the pole. In some cases these granules were seen quite well with Löffler's methylene blue, but in others they were not. Although several other staining processes were tried for bringing out the granules, nothing so successful as Neisser's method was found. Best results were got by leaving specimens in each of Neisser's solutions for one minute instead of for only a few seconds as prescribed. Lightly counterstaining with dilute carbol fuchsine accentuates the blue granules by bringing out the outline of the bodies of the the bacilli, otherwise so shadowy with Neisser's stain as to be practically invisible.

The diphtheria bacillus retains Gram extremely well and evenly.

Acid-formation.—Slightly alkaline broth containing 2 per cent· dextrose was rendered distinctly acid by all the specimens of B. diphtheriæ after 48 hours at 37° C.

Other Morphological and Cultural Characters.

It is hardly necessary to remark that B. diphtheriæ is non-motile. On *agar* at 37° C. growth is much slower than on serum. After 24 hours the colonies are small, flat, have a granular consistency, and often a slightly irregular edge. By the second day, sometimes later, the colonies may become increased in size, opaque, and raised. Exceptionally some of them may show a glistening white appearance after several days, but this is never so marked or so general as in the case of Hoffmann's bacillus. Microscopical examination of the growth on agar shows the same general appearance as with young serum cultures, but the bodies of the bacilli are rather more evenly stained. On *gelatine* at 20–22° C. in every one of the 18 cases good growth was obtained in course of time. A thick, raised, opaque growth with slightly undulating edge occurs along the streak. The colonies are slightly granular with brownish centres. No liquefaction is produced.

Broth 37° C.—Within 48 hours there is slight granular cloudiness and a scanty loose flocculent deposit on the side and at the foot of the tube. Microscopical examination shows the diphtheria bacilli to be arranged in small clumps.

Litmus milk, 37° C.—By the third day a slightly acid reaction is perceptible. This slowly increases until at the end of a month the acid reaction is well marked. In no case was clotting produced even in a month. Microscopical examination showed that the bacilli were arranged in small clumps as in the broth.

Pathogenicity.—1 cc. of a 48 hours' broth subculture at 37° C. of each of the 18 examples of B. diphtheriæ was injected subcutaneously into a guinea-pig of 200–300 grammes weight. In all cases death ensued. In 16 instances death was produced within

48 hours of injection, but in the remaining two death did not occur till the 10th and 20th day respectively. *Post-mortem* the appearance was similar in all the cases. Locally there was œdema and hæmorrhagic necrosis of the subcutaneous tissue. The nearest lymphatic glands were enlarged. The internal organs were congested, and the pericardial, and in some cases the pleural, fluid increased. In no case was the spleen enlarged, but in all the suprarenal capsules were enlarged and on section hyperæmic. In the first five cases cultures were made from the heart's blood, spleen, kidney, and liver of the guinea-pig, as well as from the local exudation. From the latter site alone was growth of the diphtheria bacillus obtained, and in each case the organism recovered. In the remaining cases, therefore, I was satisfied with either microscopically demonstrating the organism *in situ* in the local exudation, or, if this failed, with making cultures therefrom, in which case B. diphtheriæ was invariably recovered.

Brief Summary of Micro-organisms met with possessing all the four main characters of B. Diphtheriæ.

No.	Source.	Date from onset of Diphtheria when Isolated.	Morphology after 18 hours' growth on Serum, 37° C.	Neisser's stain after same.	Acid Production in Dextrose Broth after 2 days, 37° C.	Effect on Guinea-pig.
1	Throat, diphtheria	2nd day	Indistinguishable from B. diphtheriæ.	+	+	Dead, 10th day.
2	" "	3rd "	"	"	"	" 1st "
3	" "	3rd "	"	"	"	" 1st "
4	" "	4th "	"	"	"	" 2nd "
5	" "	4th "	"	"	"	" 1st "
6	" "	4th "	"	"	"	" 2nd "
7	" "	5th "	"	"	"	" 2nd "
8	" "	6th "	"	"	"	" 1st "
9	" "	6th "	"	"	"	" 20th "
10	" "	8th "	"	"	"	" 2nd "
11	" "	8th "	"	"	"	" 1st "
12	" "	9th "	"	"	"	" 2nd "
13	" "	12th week	"	"	"	" 2nd "
14	" "	14th "	"	"	"	" 1st "
15	Nose { Diphtheritic Rhinorrhœa	3rd day	"	"	"	" 1st "
16	" "	6th "	"	"	"	" 2nd "
17	Eye { Membranous Conjunctivitis	3rd day	"	"	"	" 2nd "
18	Ear { Scarlatinal .. Otorrhœa ..	52nd day	"	"	"	" 2nd "

II.—Micro-organisms not possessing all the Four Main Characters of B. Diphtheriæ.

(a.) *Those possessing three of the main characters of B. diphtheriæ, i.e., resembling it in morphology, staining, and acid-production, but devoid of pathogenicity for the guinea-pig.*

No. 1.—This micro-organism was present in a serum culture made from the throat of a case of diphtheria on the 14th day from the onset of the disease. Its morphological and cultural characters on serum, agar, gelatine, and in broth were indistinguishable from those of genuine B. diphtheriæ. The average length of the rods on serum after 18 hours' growth at 37° C. and stained with Löffler's methylene blue was 2·1 μ. Neisser's stain was positive, and a good acid reaction was produced in dextrose broth. A guinea-pig injected with 1 cc. of a 48 hours' broth subculture showed, however, no illness and no local tumour, the only change observed being some slight enlargement of a local lymphatic gland. As the micro-organism appeared to differ from genuine B. diphtheriæ in pathogenicity alone, I was inclined to regard it as probably a non-virulent form of the Klebs-Löffler bacillus. This supposition was confirmed by the behaviour of the organism to the agglutination test to be described later.

No. 2.—This organism was present in large numbers, together with a minority of staphylococcus aureus in a serum culture made from the ear discharge of a child aged 4¾ suffering from scarlatina. The ear-discharge had been present "since teething," and was therefore of long standing at onset of scarlatina four weeks antecedent to testing of the discharge.

The growth of this bacillus on serum, after 18 hours at 37° C., bore a strong resemblance to that of B. diphtheriæ. The only variation was that at some places in the film the organism was more uniformly disseminated than is usually the case with B. diphtheriæ, but at others it was arranged in clusters after the manner of that bacillus. With Löffler's methylene blue the organism resembled B. diphtheriæ in shape and in staining (Fig. 6, Plate VII.). The average length of the rods was 1·7 μ. Polar granules were frequent. Neisser's stain gave a positive result, and Gram's stain was well retained. In dextrose broth, after 48 hours at 37° C., a well marked acid reaction was produced. On agar, at 37° C., however, the macroscopic appearance of the growth was quite different from that of B. diphtheriæ. After 24 hours there was much more copious growth, and the colonies, instead of being thin, filmy, slightly granular, and flat, as is the case with colonies of B. diphtheriæ at this stage, were opaque, glistening white, homogeneous, and raised. Microscopically there was a strong resemblance to B. diphtheriæ on agar, except that the bacilli stained rather more uniformly in the present instance, and were also not longer than on serum. On gelatine, at 20° C.–22° C., there was good, raised, well-defined growth along the streak. In general appearance the growth resembled that of B. diphtheriæ; but the colonies were different, being of uniform consistency throughout, and thus differing considerably from Klebs-Löffler colonies on gelatine.

A further difference noted was that development in the present instance was faster, and that the growth also possessed more coherency than does that of B. diphtheriæ on gelatine. No liquefaction was produced. In broth, at 37° C., there was no difference, except that the growth was rather quicker than that of B. diphtheriæ.

A guinea-pig subcutaneously injected with 1 cc. of a 48 hours' broth subculture of the organism was absolutely unaffected. While, therefore, this organism bore a strong resemblance to B. diphtheriæ in some important respects, it differed in others. Although it was practically indistinguishable from B. diphtheriæ on serum and in staining reactions, and although it produced an acid reaction in dextrose broth, there was a considerable difference in respect to the macroscopical appearance of the growth on agar and on gelatine, and, moreover, the organism was non-pathogenic to the guinea-pig. Owing to the cultural differences between this organism and B. diphtheriæ, I was not inclined to regard it as a form of the Klebs-Löffler that had lost its virulence for the guinea-pig, but rather as a different kind of organism altogether. This view was confirmed later by the behaviour of the organism when subjected to the agglutination test.

No. 3.—This micro-organism was kindly given me by Mr. Brewerton, who isolated it by means of an ascitic agar culture from the conjunctiva in a case of conjunctivitis. Owing to the fact that it produces a lemon-yellow pigment the organism can at once be distinguished from genuine B. diphtheriæ. I have included it, however, because it resembles that organism in some important characters.

On serum, after 48 hours at 37° C., there is copious growth of slightly raised lemon-yellow well-defined colonies. Microscopically the growth is seen to be considerably more conglomerate than that of B. diphtheriæ; but the shape of the bacilli, and the irregular way in which they stain with Löffler, are very suggestive of the Klebs-Löffler bacillus (Fig. 7, Plate VIII.). With Neisser's stain a positive result is obtained, and a large number of the granules are situated at the poles. Gram's stain is well retained. In dextrose broth, after 48 hours at 37° C., a good acid reaction is produced. On agar, after 24 hours at 37° C., the growth is more copious than that of B. diphtheriæ, has a peculiar dry surface, and exhibits yellow pigmentation. Microscopically the conglomeration exhibited distinguishes it from B. diphtheriæ, although the individual bacilli are remarkably similar in both cases. On gelatine, at 20–22° C., the growth, though suggestive of B. diphtheriæ, is less raised, and shows the yellow pigment. In broth, at 37° C., the organism differs from B. diphtheriæ in producing no turbidity, and in growing scantily at the foot of the tube in the form of small conglomerate crumbs.

A guinea-pig injected subcutaneously with 1 cc. of a 48 hours' broth culture was quite unaffected. This chromogenic diphtheroid organism, therefore, is chiefly remarkable because of its resemblance to B. diphtheriæ in microscopical appearance, staining, and acid-production. It is quite easily differentiated

from that organism in cultural characters, in pigment-production, and in being devoid of virulence for the guinea-pig.

It has been convenient to describe the three preceding micro-organisms first, because each presented three of the four main characters of B. diphtheriæ. A considerable number of other organisms, however, have been met with in which the risk of confusion with B. diphtheriæ is not so great. These will now be considered.

(b.) *Those not possessing three of the main characters of B. diphtheriæ, but resembling it in morphology in variable degree, and sometimes resembling it in other respects as well.*

No. 4.—B. coryzæ segmentosus (Cautley).

A micro-organism which bears a resemblance to B. diphtheriæ, and apparently belongs to the Xerosis group, is B. coryzæ segmentosus, discovered by Cautley in the nasal discharge of persons suffering from acute influenza cold. (Report, Medical Officer, Local Government Board, 1894–5.) I have examined the nasal discharge in six cases of ordinary "cold in the head," an affection now often dignified in lay circles by the title of "Influenza." Microscopical examination of cover-glass preparations of the nasal discharge in such cases often reveals small groups of bacilli 1–2 μ long by ·5 μ broad, with pointed ends, staining evenly with Löffler's methylene blue, and retaining Gram (Fig. 3, Plate VI.). Large diplococci are also sometimes present, possibly in large numbers. In no case was the so-called influenza bacillus seen. In cultivations either on serum or on gelatine B. coryzæ was as a rule the most abundant organism that developed, but in all cases Hoffmann's bacillus was also recovered as well as various cocci, and, owing to their more rapid growth, these organisms were apt to cloak the presence of the smaller and slower-growing colonies of B. coryzæ.

On serum, after 18 hours at 37° C., the colonies of B. coryzæ are minute, and sometimes can hardly be seen without the magnifying glass. Microscopical examination of the growth shows that, though the bacilli occur for the most part in groups, they are not arranged in quite the same manner as in the case of B. diphtheriæ. If, however, the colonies are small the rods are relatively long. In one case the average length was 2 μ, in another 2·4 μ, and in a third an average length of 3·5 μ was reached. These rods show beading and segmentation to a very striking extent, so that the title segmentosus is an apt one (*see* Figs. 8 and 9, Plate VIII.). The ends of the rods are always round or pointed, and a few are clubbed. But while B. coryzæ shows segmentation to a greater extent than any other diphtheroid organism met with, including B. diphtheriæ itself, Löffler's methylene blue shows no granules. Neisser's stain gives a negative result: a few bacilli may show a granule, but by far the majority show none. Gram's stain gives a positive result. In dextrose broth, after 48 hours at 37° C., there is an extremely feeble production of acid, so feeble in fact that it is only after careful comparison with the reaction seen in the case of the control broth tube that it is noticed. After a week the

acid reaction is more marked, but even then it is much less intense than that produced by B. diphtheriæ in 48 hours. On agar, after 24 hours at 37° C., a faint grey misty growth is seen that, under a low power, is found to be composed of minute slightly granular, flat, well-defined colonies. The bacillus is much shorter on agar than on serum, and coccoid forms are common. Here and there a few larger clubbed forms occur. Segmentation is less marked than on serum. In all cases growth was obtained on gelatine at 20–22° C. Small flat granular, somewhat opaque colonies, with slightly irregular edges, appear in the course of several days. In streak culture there is grey, slightly raised continuous growth along the line of inoculation. The growth is much slower than that either of B. diphtheriæ or of B. Hoffmanni, and in bulk affords a considerable contrast to both, being in fact less extensive than the growth on gelatine of streptococcus pyogenes. In broth at 37° C. the fluid generally remains clear, but sometimes slight turbidity is produced. The growth chiefly occurs in small flakes at the foot of the tube. Microscopical examination shows small rods and oval or coccoid forms, often collected into small groups. In litmus milk at 37° C. an acid reaction is slowly produced, but no clotting even in a month. On two occasions when a guinea-pig was subcutaneously injected with 1 cc. of a 48 hours' broth culture mixed with the growth of a serum culture of the same age a slight illness resulted. Although no local swelling was found and death was not produced, on both occasions on the day following the injection both guinea-pigs were quiet and off their feed. By the next day, however, they had entirely recovered.

B. coryzæ segmentosus, therefore, occurs in the nasal mucus in cases of ordinary coryza. It shows marked segmentation when growing on serum, but is distinguished from B. diphtheriæ by not showing granules either with Löffler's or with Neisser's stain, and in producing a practically negative acid reaction in dextrose broth after 48 hours at 37° C. It also differs from B. diphtheriæ in growing more scantily on agar, on gelatine, and in broth. Though it appears to be capable of producing a slight passing illness in a guinea-pig, its pathogenicity is not of such a nature as to render it likely to be confused with B. diphtheriæ.

No. 5.—The bacillus of von Hoffmann.

Eight micro-organisms that appear to be identical in morphological and cultural respects with Hoffmann's bacillus have been isolated. Of these eight specimens six were associated with B. coryzæ in the nasal mucus of cases of coryza; one came from the throat of a person suspected to be suffering from diphtheria, but from whom on two occasions no diphtheria bacilli could be obtained; and, finally, one specimen was isolated from the ear-discharge of a child suffering from scarlatina.

On serum, after 18 hours at 37° C., there was in all cases excellent growth, not presenting any marked difference to the eye from that of B. diphtheriæ. Microscopical examination of a film specimen stained with Löffler's methylene blue showed in some cases conglomeration more marked than in the case of B diphtheriæ, but in others the bacilli were collected into clusters after the

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manner of that organism. It is on examining such a film with a high power (× 800 – × 1000) that the chief distinctions from B. diphtheriæ are seen (Figs. 10 and 11, Plate IX.). In the case of Hoffmann's bacillus the rods are in the first place short and stunted—the average length in my eight specimens was from 1·3 μ to 1·8 μ—but it is not length alone that will effect the differentiation of B. Hoffmanni from all examples of B. diphtheriæ. This is shown by the fact that most of the specimens of B. diphtheriæ that I have isolated have been short, and the shortest had an average of 1·7 μ. Whilst, therefore, it is undoubtedly the case that Hoffmann's bacillus is as generally stated shorter than B. diphtheriæ, it should not be forgotten that this is only a relative statement, and, owing to the prevalence of short Klebs-Löffler bacilli, of comparatively minor value therefore in some cases. A second point of difference is with regard to shape. Hoffmann's bacillus is more uniform than B. diphtheriæ. A third difference is with regard to arrangement, Hoffmann's bacillus being often arranged side by side, thus forming the so-called "paling" arrangement. The chief difference, however, between the two organisms is with regard to their staining. Hoffmann's bacillus takes up Löffler's methylene blue much more evenly throughout, and shows *no clear unstained portions and no granules.* Neisser's stain gives a negative result: a few bacilli here and there may show a granule, but the vast majority show none. Gram's stain is well retained. In dextrose broth, after 48 hours at 37° C., no acid reaction is present, but on the contrary the alkalinity is increased; this is more marked at the end of a week. On agar at 37° C. the organism grows quickly and well, the growth being much more copious than that of B. diphtheriæ. Opaque raised well-defined circular colonies are present after 24 hours' incubation, and the majority show in transmitted light a brownish tinge. Microscopically the same differences are seen as on serum. On gelatine at 20° C.–22° C. there is good growth, faster at first than B. diphtheriæ, but in older cultures the general similarity of appearance is undeniable. After one day at 37° C. the broth may be clear, and flocculi are collected at the foot of the tube. In two days there is turbidity and flocculent precipitate. Microscopical examination shows that parallel arrangement is often marked, and that there are larger clumps than in the case of B. diphtheriæ in broth. The individuals are stunted, and many are coccoid in form. In litmus milk at 37° C. an alkaline reaction is produced, which becomes stronger in the course of a month. No clotting is produced. 1 cc. of a 48 hours' broth subculture of each of the eight specimens of Hoffmann's bacillus was subcutaneously injected into a guinea-pig. In no case did any illness or local swelling result.

Hoffmann's bacillus, therefore, is short, stains more evenly than B. diphtheriæ, and shows no granules. Neisser's stain is negative, there is no acid production, and the organism is non-pathogenic to guinea-pigs. A further point of difference is with regard to the appearance of the growth on agar. These differences imply in my opinion that the two organisms are completely distinct, a view strengthened by the behaviour of B. Hoffmanni to the agglutination test.

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No. 6.—A diphtheroid organism positive to Neisser's stain.

This micro-organism was present in an agar plate-culture made from the pharyngeal mucus of a child suffering from pertussis subsequent to an attack of diphtheria. It was 77 days from the onset of diphtheria and 46 days from the onset of pertussis when the organism was isolated from this case. The chief interest of the organism lies in the fact that it gave a positive result with Neisser's stain. On serum, after 18 hours at 37° C., there was good confluent growth. In a film specimen the growth was more uniformly disseminated than is the case with B. diphtheriæ, and the individuals were small rods averaging 1·5 μ in length and rather narrower than B. diphtheriæ (Fig. 12, Plate IX.). The rods were occasionally slightly swollen at the end, and at places polar granules were seen in specimens stained with Löffler's methylene blue. Neisser's stain was positive, deeply stained granules being present at the poles of many of the bacilli. Gram's stain was well retained. In dextrose broth, after 48 hours at 37° C., no acid production was found. On agar, at 37° C., there was good white raised growth too copious and too opaque for B. diphtheriæ, and microscopically the rods were found to be short, and at places coccoid. When subjected to Neisser's stain the growth on agar, unlike that on serum, showed no granules. On gelatine, at 20–22° C., the organism failed to grow. Broth, at 37° C., was rendered slightly turbid, and conglomerate flocculi were formed at the foot of the tube. Microscopically, conglomeration was more marked than in the case of B. diphtheriæ, and the rods were shorter and narrower. In litmus milk an alkaline reaction was produced, and no clot in a month at 37° C. A guinea-pig was on injection entirely unaffected.

Although shorter and narrower than B. diphtheriæ, therefore, and although acid was not produced in dextrose broth, this organism bore some resemblance to B. diphtheriæ in that it showed polar granules with Löffler's stain, and was positive to Neisser's stain after 18 hours' growth on serum.

The two micro-organisms next to be described formed a distinct class distinguished by the fact that on all media the growth was extremely coherent, so that, in order to get a film thin enough for microscopical examination, recourse was had to forcibly crushing a piece of it between two cover-glasses. Two different varieties have been met with. Both produced an acid reaction in dextrose broth, but only the first one gave a positive result with Neisser's stain after 18 hours' growth on serum.

No. 7.—A coherent diphtheroid organism positive in acid-production and positive to Neisser's stain.

Three specimens of this type have been obtained. One came from the same case of pertussis following diphtheria as organism No. 6, and was, in fact, isolated from the same agar-plate as that organism. Another was isolated from a serum culture made from the throat of a case of diphtheria 43 days from the onset of the attack. A third specimen was obtained from a serum culture made from the nasal discharge of a case of acute coryza on the second day of the malady.

On serum, after 18 hours at 37° C., there was good growth, which was so coherent that to obtain a microscopical view of the individuals it was necessary to first separate the growth in the forcible way previously mentioned. In such a preparation, stained in the ordinary way with Löffler's methylene blue, the growth was seen to be composed of short, stout, closely packed bacilli of the Hoffmann pattern (Fig. 13, Plate X.). At places where a number of bacilli were in close lateral apposition the "paling" arrangement was seen. Some of the bacilli stained evenly with Löffler's methylene blue, but others stained more deeply at the ends than at the middle, and if the preparation were not left too long in the stain polar granules could be made out in some of them. The average length of the rods was 1·7 μ. The bacillus was too coherent and uniform for B. diphtheriæ, and was also too broad in proportion to its length to be easily confused with that organism. When, however, Neisser's stain was applied to such a "crush preparation" the overwhelming majority of the bacilli showed a granule at either pole. Gram's stain was well retained. In dextrose broth, after 48 hours at 37° C., a well marked acid reaction was produced. On agar, after 24 hours at 37° C., there was a dry white growth of opaque, circular, raised colonies. Coherency was as marked as on serum, the microscopical appearance was similar, and Neisser's stain gave a positive result. On gelatine, at 20–22° C., the organism failed to grow. In broth, at 37° C., the clearness of the fluid was unimpaired, growth occurring at the foot of the tube in the form of coherent masses. The organism produced no change in litmus milk at 37° C. in the course of a mouth's incubation. A guinea-pig injected subcutaneously with the growth in broth after 48 hours at 37° C. was quite unaffected.

When grown on serum for 18 hours at 37° C., therefore, this organism was too coherent and too uniform in size for B. diphtheriæ, as well as being too stout in proportion to its length. It gave a positive reaction with Neisser's stain, produced acid, would not grow on gelatine, and was non-pathogenic to a guinea-pig. It grew on agar in a different manner to B. diphtheriæ.

No. 8.—A coherent diphtheroid organism positive in acid-production, but negative to Neisser's stain.

The second type of coherent diphtheroid organism is represented by only a single specimen. It was isolated from an agar plate that had been inoculated with a dilution from the pharyngeal mucus of a case of diphtheria on the 11th day from the onset of the disease. The chief interest in the organism lay in the resemblance which some of its individuals bore to the longer type of B. diphtheriæ when growing on serum. On this medium, after 18 hours at 37° C., there was good growth of grey, sharply outlined colonies. On attempting to make a cover-glass preparation of it, however, the growth was found to be remarkably coherent. In order to obtain a view of the individuals the growth had to be forcibly separated, and then it was found to be composed in great part of curved bacilli, some with swollen ends and showing here and there branching (Fig. 14, Plate X.). There was considerable variation both in size and shape: length varying from 1–8 μ, and shape from a short oval form up to a mycelial thread showing branching. With Löffler's methylene blue there was

irregularity in the staining, the swollen ends of the individuals being, as a rule, more deeply stained than the rest of the body. Some also showed segmentation, and granules could be made out in a few. When subjected to Neisser's stain, however, no granules were seen. Gram's stain was well retained. In dextrose broth, after 48 hours, a well marked acid reaction was produced. On agar, at 37° C., by the third day there was a growth of raised, opaque, glistening white, firm-edged colonies. On making a cover-glass specimen coherency was found to be less prominent than on serum. Microscopically it was found that the majority of the individuals were pointed rods of varying length, but averaging about 3 μ, and staining with Löffler's methylene blue exactly in the irregular manner of B. diphtheriæ. Parts of the bodies of the bacilli were unstained; some showed segmentation, and granules were frequent, being in some cases of a reddish colour (metachromatism). Microscopically, in short, the growth on agar in this time bore a very striking resemblance to B. diphtheriæ. Unlike the serum growth, moreover, it gave a positive result with Neisser's stain. On gelatine, at 20–22° C., no growth was obtained. Broth, at 37° C., was not rendered turbid, but growth occurred at the foot in coherent lumps. On microscopical examination these were seen to be composed of short bacilli of the Hoffmann pattern. In litmus milk, at 37° C., an acid reaction was produced, and by the ninth day the milk was firmly clotted. 1 cc. of the growth in broth, after 48 hours at 37° C., was injected into a guinea-pig, but the animal was quite unaffected.

Although, therefore, this organism resembled B. diphtheriæ in a striking manner in some respects it differed from it completely in others. While the morphological appearance of the growth on serum was suggestive of B. diphtheriæ it was much too coherent, and failed to give a positive result with Neisser's stain. Although acid was produced, pathogenicity was wanting. While the growth on agar had a microscopical resemblance to that of B. diphtheriæ, and gave a positive result with Neisser's stain, there was no growth on gelatine, and milk was clotted.

No. 9.—The next organism to be described was isolated from the pharyngeal mucus of four patients suffering from diphtheria. It was in each instance isolated, in the first place from agar-plate cultures made from this material. The stage from the onset of the disease at which it was isolated was the 10th day, 39th day, 70th day, and 113th day respectively.

On serum, after 18 hours at 37° C., growth was not copious, and might be delayed till the second day. The colony was moist, grey, and raised. Coherency was not exhibited. On microscopical examination great variation of shape was seen. Every transition was present from a circular or oval coccoid form up to bloated pear-shaped bodies, some of which showed branching (Fig. 15, Plate X.). Most of the individuals stained evenly and deeply with Löffler's methylene blue. A few, however, showed granules and unstained portions. With Neisser's stain many of the individuals were seen to show granules. Though some of the rods showed a granule at either pole the majority showed only a granule at one end, or else had several granules scattered about the rest of the body. In dextrose broth at 37° C, after 48 hours a strongly

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acid reaction was produced. Gram's stain was well retained. On agar after 24 hours at 37° C. there was good grey growth of round granular raised colonies that *adhered* to the medium. Microscopically conglomeration was marked and though there were a few diphtheroid forms, the majority of the individuals were more of a coccal shape. With Neisser's stain a positive result was obtained. On gelatine at 20–22° C. there was slight grey raised growth, and at the 10th day it began to liquefy the gelatine. In broth at 37° C. slight turbidity was produced and a weedy sediment collected at the foot. Microscopically the organism was seen to be in the form of a short cocco-bacillus. In litmus milk in each of the four cases a strongly acid reaction was produced, and the milk was clotted on the 6th day. A guinea-pig injected with 1 cc. of a 48 hours' broth culture of the organism was unaffected.

This micro-organism, therefore, was quite distinct from B. diphtheriæ. Its chief interest lay in the fact that, after 18 hours' growth on serum at 37° C., some few of its individuals had a morphological resemblance to B. diphtheriæ, and gave a positive result with Neisser's stain.

No. 10.—Besides the above micro-organisms another one has been met with that deserves notice, although it would not grow on serum. This organism was a streptothrix, and it was isolated from the pharyngeal mucus of a patient 43 days from the onset of diphtheria by means of a surface agar-plate culture.

On serum at 37° C. there was no growth. On agar, however, there was good growth of raised granular well-defined colonies wrinkled on the surface, and adherent to the medium. Microscopical examination showed that the growth exhibited some coherency, and that it was composed of a streptothrix often broken into pieces, in which case the broken-off bits bore a remarkable resemblance to diphtheria bacilli, and at places showed granules. With Neisser's stain a positive result was obtained (Fig. 17, Plate XI.), some of the granules being polar and others not. Gram's stain was well retained. In dextrose broth after 48 hours at 37° C. a good acid-reaction was produced. On gelatine at 20–22° C. there was grey slightly-raised growth that became wrinkled transversely, and began to liquefy the gelatine on the 14th day. In broth at 37° C. faint turbidity was produced, and there was a slight sediment of growth at the foot of the tube. Microscopical examination of the broth showed a short branching streptothrix that tended to collect in small groups in which were many diphtheroid forms. In litmus milk at 37° C. no change was produced during a month at 37° C. 1 cc. of a 48 hours' broth culture injected subcutaneously into a guinea-pig produced no effect.

The chief interest in this streptothrix lay in its origin, and also in the fact that it gave a positive result with Neisser's stain. Although it would not grow on serum, when growing on other media many of its individuals bore a morphological resemblance to forms of the Klebs-Löffler bacillus.

Among other diphtheroid forms occasionally met with in young serum cultures from the throat are some bacillary-shaped individuals bearing a close resemblance in outline to B. diphtheriæ,

but these were found on investigation to be phases of various throat streptococci.* They are not, however, so common in young serum cultures as in older ones, or as in agar cultures; they as a rule, but not always, stain evenly; and finally, all those that I have hitherto tested with Neisser's stain have quite failed to show granules. It should also be mentioned that bacilli are occasionally met with in serum cultures from the throat that do not stain with Gram.

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BRIEF SUMMARY of MICRO-ORGANISMS met with, resembling B. DIPHTHERIÆ, but not possessing all its four main characters.

No.	Source.	No. of specimens obtained.	Morphology after 18 hours' growth on serum at 37° C.	Neisser's stain after same.	Acid-production in dextrose broth after 2 days at 37° C.	Effect on guinea-pig.	REMARKS
1	THROAT. (Diphtheria.)	1	Indistinguishable from B. diphtheriæ.	+	+	Slight enlargement of local lymphatic gland.	Growth on agar and gelatine indistinguishable from that of B. diphtheriæ.
2	EAR. (Scarlatina.)	1	*Strongly resembles B. diphtheriæ.	+	+	None ..	Growth on agar and gelatine different from that of B. diphtheriæ.
3	EYE. (Conjunctivitis.)	1	*Suggestive of B. diphtheriæ.	+	+	None ..	Chromogenic.
4	NOSE. (Coryza.)	6	*The marked segmentation and beading suggests B. diphtheriæ.	-	So feebly + that practically -.	Quiet next day in 2 cases.	B. coryzæ segmentosus.
5	THROAT. (Diphtheria.) NOSE. (Coryza.) EAR. (Scarlatina.)	8	*Shorter and relatively broader than B. diphther'æ. Stains evenly.	-	-	None ..	Hoffmann's bacillus.
6	THROAT. (Pertussis, after diphtheria.)	1	*Too small for B. diphtheriæ.	+	-	None ..	No growth on gelatine.

* *See* plates illustrating this report.

* The remarkable morphological resemblance between some of the individuals formed by S. scarlatinæ on serum, and B. diphtheriæ on the same medium was specially emphasised and illustrated in my last report. It is quite possible that the resemblance has in the past led to these two microbes being confused.

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BRIEF SUMMARY of MICRO-ORGANISMS met with, resembling B. DIPHTHERIÆ, but not possessing all its four main characters—*continued.*

No.	Source.	No. of specimens obtained.	Morphology after 18 hours' growth on serum at 37° C.	Neisser's stain after same.	Acid production in dextrose broth after 2 days at 37° C.	Effect on guinea-pig.	REMARKS.
7	THROAT. (Pertussis after diphtheria.) NOSE. (Coryza.)	3	*Too coherent, short and proportionately broad, for B diphtheriæ. Stains evenly.	+	+	None ..	Very coherent. No growth on gelatine.
8	THROAT. (Diphtheria.)	1	*Somewhat suggestive of long B. diphtheriæ. Branching.	–	+	None ..	Coherent. No growth on gelatine. Milk clotted 9th day
9	THROAT. (Diphtheria.)	4	*A few individuals suggestive of B. diphtheriæ. Branching.	+	+	None ..	Many small oval forms. Gelatine liquefied. Milk clotted 6th day.
10	THROAT. (Diphtheria.)	1	No growth ..	..	+	None ..	Streptothrix. Wrinkled growth. Agar 1 day = *Neisser +. Gelatine liquefied.

* *See* plates illustrating this report.

Summary.

Micro-organisms, therefore, not identifiable with B. diphtheriæ, but bearing resemblance to it, have been divided in the first place into two groups, according as they do or do not possess three of the four main characters of that organism. Of the former group the three specimens described were of three different kinds; No. 1 appeared to be an example of B. diphtheriæ deficient in virulence for the guinea-pig, but both Nos. 2 and 3 appeared to be of different nature. No. 3 in fact was chromogenic.

In respect of the morphological and staining characters of the growth on serum after 18 hours at 37° C., these three organisms approached genuine B. diphtheriæ more closely than did any of the remaining seven. Although the latter resembled the prototype in varying degree and manner, the points in which they differed from it were sufficiently great to justify the inference that they were not modifications of the Klebs-Löffler bacillus, but quite distinct micro-organisms. Nos. 8 and 9 were suggestive of the streptothrix group, and No. 10 undoubtedly belonged to that class.

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Only one of the 10 different kinds of diphtheroid organisms obtained, therefore—namely, No. 1—passed for B. diphtheriæ in all morphological, cultural, and staining respects examined.

With regard to the liability of these organisms to be mistaken for B. diphtheriæ in actual practice, I believe that with care and experience the danger is not great, provided their existence is realised. It is when the subject is viewed too narrowly, when in fact it is looked upon too exclusively from the point of view of B. diphtheriæ, that mistakes are most likely to be made. It is also necessary to realise that though perhaps the commonest, Hoffmann's bacillus is not the only one with which confusion may arise. These investigations also go to show that forms of B. diphtheriæ that are non-pathogenic to the guinea-pig are comparatively rare. If a serum culture is used in the first place, and if after incubation for 18 hours or thereabouts at 37° C., a diphtheria-like organism is present that distributes over the cover-glass film in clusters characteristic of B. diphtheriæ, that stains with Löffler's methylene blue in the manner of B. diphtheriæ, and that, thirdly, shows bipolar granules with Neisser's stain, my present observations lead me to infer that such an organism is in the overwhelming majority of cases the Klebs-Löffler bacillus. Without Neisser's stain, however, the danger of confusion is much increased. Some forms of Hoffmann's bacillus are sufficiently like some of the shorter forms of the genuine Klebs-Löffler to cause doubt when stained with Löffler's methylene blue, and Hoffmann's bacillus is sufficiently common to render it specially desirable that its confusion with B. diphtheriæ should be prevented. Neisser's stain is, therefore, of real value in excluding Hoffmann's bacillus, and it is of equal value in excluding B. coryzæ segmentosus, an organism that from its irregular staining, its length, and its beaded appearance when growing on serum may easily be confused with B. diphtheriæ, especially when a nasal discharge is under examination.

Some of the other diphtheroid organisms that have been met with would also be excluded by Neisser's stain. Others that show granules with Neisser would be suspected or excluded by their greater breadth in proportion to their length, by their more uniform size, or by their coherency. The diphtheroid organisms that would not be excluded from being confused with B. diphtheriæ, after careful scrutiny of specimens of the serum growth under the conditions named, appear to be proportionately few in number, and, accordingly, the error per cent. occasioned by them in diagnosis at the present time is not, I suspect, large. In this, as in other branches of bacteriology, however, mistakes are very easily made, especially by those who are unaware of the profusion and variety of forms chiefly saprophytic with which specific pathogenic micro-organisms are liable to be confounded. And particularly in the identification of B. diphtheriæ from its morphological and staining characters alone does accuracy depend on the training, care, and personal skill of the observer to whom this important duty is entrusted.

III.—Agglutination Experiments.

The investigation of the application of the agglutination test for the purpose of distinguishing B. diphtheriæ from allied micro-organisms has been complicated by the difficulty of getting an emulsion showing the bacilli sufficiently separated. If a broth culture of B. diphtheriæ, or of Hoffmann's bacillus, or of B. coryzæ segmentosus is examined microscopically it is seen that the bacilli grow naturally therein in the form of clumps, hence it is not possible as in the case of members of the coli-typhoid family to use a broth culture of the organism for the purpose of the agglutination test. After many fruitless attempts I have at length succeeded in getting a suitable emulsion by using the method devised by Dr. Klein when testing the plague bacillus for agglutination. The principle of the method is the use of a platinum needle as a pestle and the surface of a gelatine slope as a mortar. A little of the growth from a surface agar culture of 2–3 days' growth at 37° C. is transferred by means of a platinum loop to the gelatine slope and thoroughly distributed over the surface of the gelatine. It is best to use only a little of the growth and to separate it in the way mentioned as thoroughly as possible. Up to the present I have got better emulsions from agar cultures than from cultures on gelatine. When the growth has been separated as much as possible, a few drops of sterilised normal saline are poured into the gelatine tube, and the growth distributed over the surface of the gelatine is suspended in the fluid by allowing the latter to run over the surface and at the same time raking with a platinum needle. Some of the emulsion of diphtheria bacilli is now drawn up into a capillary pipette and a drop of it examined microscopically. If the bacilli are free and there are no clumps the emulsion is fit for testing, but if there are clumps it will be necessary to make another emulsion.

The animals that have hitherto been employed for furnishing serum for this test have been guinea-pigs. They were each injected subcutaneously with the total growth scraped off the surface of two agar cultures of 3–7 days' growth at 37° C. The growth had been washed off the surface of the agar in 1–2 cc. of sterilised normal saline, and the emulsion in this way obtained was killed by heating to 70° C. for 10 minutes. It is important to inject as large a bulk of the bodies of the bacilli as possible. When testing the blood of one of these "prepared" animals the ear is sponged with warm water, and, after drying it, a peripheral vein is pricked. The drop of blood which oozes out is drawn up in a capillary pipette and the point reached by it marked with a chalk pencil.* The blood is then blown out into a sterile watch-glass, and the capillary pipette refilled up to the chalk mark with salt solution, which is then blown out on to the top of the blood in the watch-glass. This is repeated eight times, so that the blood is diluted nine times. Equal parts of this 1 : 10 dilution and of the emulsion of the bacillus to be tested are then mixed together on a slide, a cover-glass is placed on the top, and the preparation ringed to prevent evaporation. In all the tests a total dilution

* This particular way of making the dilution was introduced, I believe, by Professor Wright.

of 1 : 20 (as above) has been used unless it is expressly stated otherwise. The preparations were examined microscopically with a magnification of about 500 diameters, and kept under observation for 1 hour. No experiment is recorded unless a control experiment made with the emulsion of the bacillus and normal guinea-pig's blood mingled together in the same proportion, viz., 1 : 20, and kept under the same external conditions, was entirely negative.

The first point to be determined was whether the diphtheria bacillus is agglutinated by the blood of a guinea-pig that has been repeatedly injected with killed cultures of the diphtheria micro-organism. The experiments made were as follows :—A guinea-pig received three subcutaneous injections of emulsified diphtheria bacilli, at intervals of a week between each injection. After the third dose its blood was tested against the bacillus of injection and no clumping was seen. After a fourth injection, however, the blood distinctly agglutinated the bacillus of injection, and after a fifth the same result was obtained. After the seventh injection the blood was tested on three occasions, and on each a positive result was obtained with the bacillus of injection. An experiment made to determine the extent to which the blood possessed a capacity for agglutinating the bacillus of injection showed that agglutination was produced when the blood was diluted 100 times, but not when it was diluted 500 times. A second guinea-pig received in the same way seven killed doses of the same organism, and when its blood was then tested it was found to agglutinate the bacillus of injection. A third guinea-pig received five injections, and had enlargement of the local lymphatic glands. Its blood possessed the power of agglutinating the bacillus of injection in a very complete manner.

It follows, therefore, that the living diphtheria bacillus is agglutinated by the blood of a guinea-pig repeatedly injected subcutaneously with killed doses of it. Moreover, when diluted 100 times, the blood of such an animal may be capable of agglutinating the bacillus of injection. The example of the diphtheria bacillus used in the preceding experiments was the laboratory stock culture. This organism—a long form of the diphtheria bacillus, came originally from the throat of a typical case of diphtheria, and has been in culture for six years.

Hoffmann's bacillus was next tested in the same way. Killed doses of the agar growth were used for injection. After three injections the blood of the first guinea-pig was tested against an emulsion of the bacillus of injection. No clumping was obtained. After four injections, however, agglutination was produced, and the same result was obtained in tests made after the fifth, sixth, and seventh injections. Tested quantitatively after the seventh injection the blood gave clumping when diluted 100 times, but not when diluted 500 times. A second guinea-pig received five doses of the same bacillus, after which its blood clumped the bacillus of injection. A third guinea-pig gave a similar result.

It follows, therefore, that Hoffmann's bacillus also is agglutinated by the blood of a guinea-pig that has received repeated subcutaneous injections of Hoffmann's bacillus. The blood of such a

guinea-pig may be capable of agglutinating the bacillus of injection when diluted 100 times. The culture of Hoffmann's bacillus used for these experiments was the laboratory stock culture of that organism, and it had been isolated two years previously from the sputum of a case of bronchitis.

Some cross-testing experiments were then made. On six occasions, when the blood of the guinea-pig that had been injected with the diphtheria bacillus was proved to agglutinate the bacillus of injection, the blood was also tested against an emulsion of Hoffmann's bacillus. On no occasion was agglutination produced. Conversely, on six occasions when the blood of the guinea-pig that had been injected with Hoffmann's bacillus was proved to agglutinate the bacillus of injection, the blood was also tested against an emulsion of the diphtheria bacillus. Here again on no occasion was agglutination produced.

It follows, therefore, that the blood of a guinea-pig repeatedly injected with an emulsion of killed diphtheria bacillus, while clumping that organism, has no such effect on the bacillus of Hoffmann, and also that the same statement is true, *mutatis mutandis*, in the case of a guinea-pig injected with Hoffmann's bacillus. Micro-photographs of four preparations showing these points are appended (Figs. 18 to 21, Plate XII).

I now proceeded to test the agglutinative power of the blood of a guinea-pig repeatedly injected with killed laboratory culture of B. diphtheriæ, and possessing the power of agglutinating the bacillus of injection in a complete manner, for two other examples of the diphtheria bacillus more recently isolated. I was surprised, however, to find that no agglutination took place.

The blood of a guinea-pig repeatedly injected with killed laboratory culture of Hoffmann's bacillus, and clumping well the bacillus of injection, was then tried against two other recently isolated specimens of Hoffmann's bacillus. Of these two, one had been isolated from the throat of a person suspected to be suffering from diphtheria, the other from the nasal discharge of a case of acute coryza. The former was clumped as thoroughly as the bacillus of injection, but the latter showed no agglutination.

The blood of the same guinea-pig was tried against the three organisms met with in this enquiry and previously described, and found to possess three of the four main characters of B. diphtheriæ. It was also tried against B. coryzæ. In all these cases no agglutination resulted.

Owing to the unsatisfactory results as regards other micro-organisms, apparently of the same species, obtained with the blood of the guinea-pigs injected with the laboratory stock cultures of B. diphtheriæ and of B. Hoffmanni respectively, it was desirable to inject guinea-pigs with more recently isolated examples of these micro-organisms, and to see what agglutinative action the blood of such animals would have. This was accordingly set about, killed cultures being used for injection as in previous experiments. The results obtained up to the present time have been as follows:—The blood of two guinea-pigs, each injected with a specimen of recently

solated B. diphtheriæ, had in both cases the same agglutinative properties. But while both bacilli of injection were clumped equally well with either guinea-pig's blood, the same blood possessed no agglutinative action on the laboratory stock culture of B. diphtheriæ. Of six other recently isolated examples of B. diphtheriæ tested, four were clumped by the blood of the guinea-pigs, but two were not.

Micro-organism No. 1 of those in the list of organisms that possessed three of the four main characters of B. diphtheriæ, an organism that, unlike No. 2 in the same list, was quite indistinguishable from B. diphtheriæ in morphological and cultural respects, was now tested against the blood of each of these guinea-pigs. It was agglutinated as thoroughly as the bacillus of injection.

Micro-organism No. 2 of those in the same list of organisms that possessed three of the four main characters of B. diphtheriæ was now tested. It will be remembered that this organism resembled B. diphtheriæ in morphology on serum, in staining properties, and in acid-production, but on account of the different character of its growth on agar and on gelatine, and also on account of its being non-pathogenic for the guinea-pig, had been considered to be a different organism from B. diphtheriæ. This micro-organism was not agglutinated by the blood of the same diphtheria guinea-pigs.

Micro-organism No. 3 of the same series, an organism that produced pigment, was also tested against the blood of the same guinea-pigs. No agglutination was shown. Examples of Hoffmann's bacillus and of B. coryzæ segmentosus were also not agglutinated by the blood of the same animals.

It is as yet too early to formulate conclusions from these experiments. The results so far obtained, however, seem to imply that, as a means of identifying B. diphtheriæ, the agglutination test promises to be of more use in its positive than in its negative aspect. The only organism met with in the course of this enquiry that was morphologically and culturally indistinguishable from B. diphtheriæ, and differed from it solely in deficiency of virulence for the guinea-pig, gave a positive result as regards agglutination with the blood of the two guinea-pigs that had been repeatedly injected with killed doses of two recently isolated virulent specimens of B. diphtheriæ. But while the blood of the same animals failed to agglutinate organisms distinct from B. diphtheriæ in morphological and cultural respects, it also failed to agglutinate two recently isolated organisms that possessed the four main characters of B. diphtheriæ.

No. 5.

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On Agglutination of Microbes by Blood with special reference to Specificity; by Dr Klein, F.R.S.

REPORT on AGGLUTINATION by BLOOD of EMULSIONS of MICROBES, with SPECIAL REFERENCE to SPECIFICITY; by DR. E. KLEIN, F.R.S.

The process of agglutination of microbes by the blood serum of an animal previously prepared or immunised has been well established through the labours of Bordet, Gruber, Durham, and others. Thus, it is now generally understood that if an animal is repeatedly injected with a given microbe its blood (or blood serum) sooner or later acquires the power of agglutinating and precipitating, from a broth culture or from an emulsion, the bacteria with which the animal has been prepared. Widal was the first who published the fact that agglutination of an emulsion of typhoid bacilli is effected by blood of a patient still in the early stages of typhoid fever, and the knowledge thus acquired has been justly considered as an important help to diagnosis. Hence this " Widal test " is constantly practised, and practised with obvious success, in typhoid fever cases and in cases of illness suspected to be typhoid fever. But there exists a diversity of opinion both as regards the degree of dilution at which the agglutination test is to be relied upon, as also as regards the power of typhoid blood to agglutinate other microbes, *e.g.*, bacillus coli and coli-like microbes. As a matter of fact French writers (Remy and others) have stated that they have obtained coli-like microbes from the typhoid intestine which were agglutinated by typhoid blood in very high dilutions, and they have therefore inferred that the Widal test when used for differentiating typhoid from coli-like bacilli has not the diagnostic value attributed to it by many other observers.

In reinvestigating this subject, I have especially sought to obtain from the typhoid intestine B. coli and coli-like microbes which show the character of becoming agglutinated in very high dilutions (1 in 200, 1 in 400) by typhoid fever-blood, that is to say in dilutions considered generally as specific only for typhoid bacilli.

Very early in the inquiry it was found, as has been found by others (Remy, Köhler, for instance), that there exists much diversity among enteric fever patients as regards the degree of dilution at which their blood agglutinates one and the same strain of typhoid bacillus. Also it was proved that though some typhoid blood, both of man and of prepared animals, is capable of causing agglutination of bacilli other than typhoid bacilli, there is very rarely, if at all, any blood except typhoid fever-blood which agglutinates the typhoid bacillus. And a further fact which I have met with is this :—Not any coli-like microbes isolated from a number of typhoid fever cases showed the slightest tendency to become agglutinated by typhoid blood. It should be mentioned, however, that owing to an exceptional relative scarcity of cases of typhoid fever at St. Bartholomew's Hospital, and seemingly also

in other hospitals, during last season (Autumn and Winter 1901–1902), the number of cases at my disposal have not been as large as I should have desired; so that the results obtained on this particular point are not based upon a satisfactory number of observations.

In my report in this volume on plague-prophylactic I have described in detail the method which I use in determining the agglutinating power of plague blood on an emulsion of plague bacilli. This method in all essential particulars I have used in regard to typhoid and other blood in testing agglutinating power. My practice has been as follows :—

From a recent (2–4 days old) gelatine culture of the typhoid bacillus a small particle is removed with a sterile platinum loop and distributed in sterile bouillon. The bacillary mass is readily distributed so as to form a uniform emulsion. The bacilli of a recent gelatine culture are always markedly cylindrical and thread-like, and very motile; two conditions which in my experience favour their ready agglutination by typhoid blood. Neither broth culture nor an emulsion of an agar-culture are in these respects, viz., cylindrical shape and motility of the bacilli, comparable to the emulsion of gelatine culture. Without of course implying that the bacilli of either broth or agar-culture are inferior in capability to become agglutinated by typhoid blood, I am prepared to maintain from a large experience that the more cylindrical (or even filamentous) and the more motile the typhoid bacilli, the quicker and the more conspicuously do they become agglutinated,—other things being equal. In the experiments to be described I have therefore invariably used gelatine cultures 48 hours old, not only of the typhoid bacilli but also of the bacilli belonging to the colon-typhoid group. In all experiments with the typhoid bacillus I have invariably employed sub-cultures of one and the same strain of typhoid bacilli used in the laboratory now for more than a year. As regards the agglutination test itself I have invariably relied on the microscopic test. In all cases a definite amount of the blood serum is directly added to a definite amount of the bouillon emulsion, which contains the bacilli fairly numerously but not too copiously. The emulsion is just noticeably turbid. After the mixing of the serum and the emulsion a hanging drop preparation is made and observed under the microscope. As mentioned in my report on plague-agglutination, I have avoided as much as possible the introduction of unknown factors, *e.g.*, heating the mixture or adding other fluids to it. In my view the simplest method as at present used is already sufficiently complex, and the introduction of further and unknown factors certainly would not simplify the phenomena. When in the experiments to be described presently comparative tests are mentioned, *i.e.*, tests with a given blood on emulsions of several species of microbes, it is always to be understood that the emulsions were in sterile bouillon and were invariably made from gelatine cultures of exactly the same standing, *i.e.*, the same age, generally 48 hours, at 23° C. Another point which I wish to emphasise is that, like Durham, I have used generally the dilution of 1 in 100. From a large experience I hold with Dr. Durham that if any blood serum in this dilution

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agglutinates the typhoid emulsion of a particular strain in a decided manner, *i.e.*, within one hour, it may, generally speaking, be considered as in all probability derived from typhoid blood. I am not of course maintaining that if a given blood serum does not agglutinate in dilution of 1 in 100 it is not typhoid blood. This would be contrary to well ascertained facts noted by other observers, including myself; for some samples of blood of unquestionably typhoid fever patients have been occasionally observed which do not agglutinate in greater dilution than 1 in 30 or 1 in 40. But as regards determination of the precise nature of doubtful fever cases in hospital, I am of the same opinion as Dr. Horton Smith (Gulstonian Lectures, Lecture III., p. 78), viz., that the test made in dilution of 1 blood serum in 20 typhoid emulsion, time limit one hour, is in the vast majority of instances quite reliable, since a positive result denotes typhoid, a negative result non-typhoid blood.

I. To illustrate the great differences as regards agglutinative power existing between typhoid blood of different fever cases, I quote from my notes a few examples. The cases were all typical typhoid fever cases of between one and three weeks' duration, and the sera were tested on 48 hours old gelatine cultures of my laboratory strain of B. typhosus.

1.—B. C., young girl, typical typhoid fever.

Tested, dilution 1 : 100 : slight indication in 30 minutes, good partial clumping in one hour.

2.—A. M., aet. 14, typical typhoid fever.

Tested, dilution 1 : 100 : distinct clumping in five minutes, complete in 15 minutes.

3.—D. M., aet. 27, typical typhoid fever.

Tested, dilution 1 : 100 : distinct clumping in five minutes, complete in 17 minutes.

4.—C. W., aet. 13.

Tested, dilution 1 : 100 : indication of clumping in 30 minutes, not advanced in one hour.

5.—W. W., aet. 10½, 16th day of typhoid fever.

Tested, dilution 1 : 100 : complete agglutination in 15 minutes.

6.—E. H., aet. 20, third week of typhoid fever.

Tested, dilution 1 : 100 : indication of agglutination in 20 minutes, a little better 30 minutes; slight partial clumping in one hour.

This fact of differing agglutinating power of samples of typhoid blood from different patients has been of course observed by others, but I mention it here in order that the experiments which I have carried out on other than typhoid emulsions may be better judged of.

II. This second series, experiments was undertaken with emulsions of a number of coli and coli-like bacilli isolated from typical typhoid stools of typical typhoid fever cases. The isolation

of the micro-organisms was carried out in this way. From a dilution of the "pea soup" stool a phenol-agar surface plate was established, and, after 48 hours incubation, sub-cultures in different media were made from all existing colonies exhibiting different characters as to general aspect and microscopic appearances (observation in bouillon in the hanging drop). These characters were then studied in respect of similarity or dissimilarity with the typical bacillus coli communis.

A. From a typhoid stool there were isolated two varities of B. coli.

(*a*) One corresponded in all respects with B. coli communis: few individuals motile in hanging drop.

(*b*) The second variety formed acid in litmus milk, but did not clot milk, and was highly motile.

The blood of a guinea-pig fully protected against a dose of typhoid bacillus by repeated minor injections with living typhoid bacilli, agglutinated the emulsion of my laboratory strain of typhoid bacilli completely in 15 minutes; dilution 1 in 100.

This same blood was tested on emulsions of the above two varieties of B. coli; dilutions 1 in 50 and 1 in 20. In neither case was there a sign of agglutination in one hour.

B. A typical typhoid stool from which two varieties of B. coli were isolated. Neither of them were quite the same as B. coli communis, since they did not coagulate milk; one (*a*) was feebly motile, the other (*b*) was very motile and more cylindrical than (*a*) and than B. coli communis. Test was made with blood of a typhoid guinea-pig protected by several previous typhoid injections. This blood gave complete agglutination of typhoid emulsion in 30 minutes, dilution 1 in 50. Emulsions of the above two varieties of B. coli showed, however, no trace of agglutination (dilution 1: 20) in one hour.

C. A typical typhoid stool from which were isolated: (*a*) B. coli communis, and (*b*) a coli-like bacillus distinctly cylindrical, which did not clot milk, and was non-motile, but which in other respects belonged to the coli group.

Emulsions of both of these microbes were tested with typhoid blood which agglutinated typhoid emulsion (dilution 1: 50) distinctly in 10 minutes. On neither of the two microbes had this blood any agglutinating action. Dilution 1: 20 showed negative result in one hour.

D. A typical typhoid stool from which were isolated, besides typical B. coli communis, two varieties of B. coli. Both these varieties gave gas in gelatine shake culture, produced acid in litmus milk, and gave indol, but neither curdled milk. One (*a*) was markedly cylindrical and non-motile, the other (*b*) was of the size of typical B. coli and was motile.

Emulsions of the B. coli of variety (*a*) and of variety (*b*) showed no agglutination with typhoid blood (dilution 1: 50) in one hour, whereas the same blood agglutinated typhoid emulsion 1: 100 in 30 minutes.

E. A fifth typhoid stool was subjected to culture in phenol-agar plate, and from it a variety of B. coli was isolated which showed all the characters of B. coli communis except that its streak growth on gelatine was thicker and more limited than in a corresponding B. coli communis streak culture; in addition it did not curdle milk. This bacillus was distinctly motile and virulent to rodents.

An emulsion of this variety showed no sign of agglutination with blood (1 : 50) of guinea-pigs immunised against typhoid bacillus. The blood in question, however, agglutinated emulsion of typhoid bacilli in 15 minutes quite completely (dilution 1 in 100).

F. From a typhoid stool there were isolated three different varieties of colon-like microbes; (*a*) formed gas in shake culture, was non-motile, was in streak more translucent than typical B. coli; (*b*) formed no gas in shake culture, was opaque in streak; (*c*) formed gas in shake culture, was very motile, and was cylindrical in shape. None of these three varieties exhibited the slightest agglutination with typhoid blood (dilution 1:50). This blood gave good clumping of typhoid emulsion (dilution 1:100).

From these experiments it is obvious that the bacillus coli communis and coli-like microbes isolated from six typical typhoid stools showed no agglutination whatever with typhoid blood (dilution 1:50), whereas such blood agglutinated typhoid emulsion in a marked degree (dilutions 1:50 and 1:100.) It would appear, therefore, that the presence of coli-like bacilli in the typhoid intestine possessing the character of becoming agglutinated by typhoid blood, whether in high or low dilution, cannot be considered as of common or general occurrence. Although the observations which I have been able to make on this point are not very numerous, they raise presumption that little difference exists in this sense between B. coli as obtained from the typhoid intestine, and B. coli from other sources; and they corroborate the observations of numerous observers, viz., that emulsion of B. coli is not agglutinated by typhoid blood in any high dilution.

In this connection I have made experiments with B. coli communis obtained from several separate sources as follows:—

(1.) From three different samples of sewage.

(2.) From the semi-fluid stool of a case of diarrhœa.

(3.) From the sputum of a case of severe broncho-pneumonia

(4.) From the urine of a case of cystitis.

[The three last named cases occurred in St. Bartholomew's Hospital.]

(5.) From two fluid stools of cases of English cholera.

None of the B. coli communis from these sources showed the slightest sign of agglutination with typhoid blood (dilution 1:50) after one hour, whereas this same blood agglutinated typhoid emulsion markedly (dilution 1:100).

Köhler (Klin. Jahrbuch, Vol. VIII., 1901, No. 1) found that of 27 different strains of B. coli derived from typhoid stools, 13 gave no agglutination with the patients' blood, while nine gave positive and other five doubtful results. Further, he found that some strains of coli which did not agglutinate with typhoid blood, agglutinated positively with normal blood.

Köhler's positive results have, however, not much bearing on the matter; he used the blood serum in very low dilutions. Drs. Andrews and Scholberg (Meeting of the Pathological Society, January, 1901) have already shown that a certain amount of agglutination can be demonstrated with the typhoid blood on B. coli communis in low dilution such as 1:20.

My observations therefore, as far as they go, lend no countenance to the view that B. coli communis, derived directly from a typhoid fever intestine, is apt to possess the power of becoming agglutinated by typhoid blood in high dilution. Nevertheless there is possibility that there exist certain varieties of the extensive group of coli-like microbes—outside or inside the normal or diseased human animal body—which can react in a positive sense to the Widal test with typhoid blood; and I propose to describe here some of the numerous experiments which I have made in search for such varieties.

Dr. Durham (*The Lancet*, 1898, p. 154), Dr. Lorrain Smith (*British Medical Journal*, January 28, 1899), and Drs. Andrewes and Scholberg (Pathological Society, January 1901), Dr. Horton Smith, and others*, have shown that typhoid blood gives positive agglutinating reaction on the varieties of coli, known as Gärtner, and on similar bacilli; as for instance a bacillus very motile, cylindrical, pathogenic to rodents, producing gas in shake culture, not curdling milk, producing at first acid and then alkaly in litmus milk. The positive agglutinating reaction of typhoid blood on the Gärtner bacillus is, however, as was pointed by all the above observers, inferior to the reaction of the same blood on the typhoid bacillus, inasmuch as a given typhoid blood will invariably agglutinate the typhoid bacillus in a higher dilution than it will agglutinate the Gärtner and similar bacilli.

I have made a considerable number of observations to be presently mentioned which fully confirm the previous observations described by Durham, Lorrain Smith, Horton Smith, and others; and I have found that the coli-like bacillus known as Danysz' rat bacillus also behaves in precisely the same manner as the Gärtner bacillus towards typhoid blood.

The Danysz bacillus has been shown to be pathogenic to rodents on subcutaneous and on intraperitoneal injection, as also to a lesser degree by ingestion. It is to be noted, however, that the alleged great mortality, and therefore ready destruction of rats in a wholesale manner, by the ingestion of cultures of this

* For the literature on the serum test as regards typhoid bacilli—*See* Dr. Horton Smith, Gulstonian Lectures, 19:0, and Kohler Klin. Jahrbuch. vol. viii., 1901.

bacillus as was maintained by Danysz, has not been confirmed either abroad or in this country (Klein and Williams, *The Lancet*, August 17, 1901, p. 440.)

This bacillus has been subjected by me to a careful study, and I have shown (Pathological Society of London, November 19th, 1901), that in morphological cultural and experimental respects, the Danysz rat bacillus and the Gärtner bacillus are not only very closely related but would seem to be almost identical. This conclusion is still further supported by: (1) the fact that both behave in exactly the same way as regards agglutination by typhoid blood; (2) that the blood of an animal immunised against the one agglutinates (with slight unessential variations) the emulsion of the other bacillus; and (3) that an animal immunised against the one is at the same time immunised against the other.

I need not dwell longer on these facts, and I proceed to give details of some further study as to the agglutination observed on emulsions of (*a*) the typhoid bacillus, (*b*) the Gärtner bacillus, and (*c*) the Danysz bacillus; when these severally are brought in relation with typhoid blood, with the blood of a guinea-pig immunised against Danysz's bacillus, and with the blood of the same species of animal immunised against the bacillus of Gärtner.

Series I.

**Tests with typhoid blood.*

1. Blood serum of a typical case of typhoid fever in the third week of illness, tested—

(*a.*) On emulsion of typhoid bacillus (dilution 1 : 100).
Result: indication of clumping in five minutes, partial clumping in 10 minutes; in 20 minutes clumping practically complete.

(*b.*) On emulsion of Gärtner bacillus (dilution 1 : 100).
Result: negative in one hour.

2. Blood serum of a guinea-pig injected several times with culture of the typhoid bacillus, tested—

(*a.*) On typhoid emulsion (dilution 1 : 100).
Result: indication of clumping in 10 minutes, partial clumping in 25 minutes, practically complete clumping in 45 minutes.

(*b.*) On emulsion of Gärtner bacillus (dilution 1 : 100).
Result: fair number of small clumps in 30 minutes, fair partial clumping in one hour.

(*c.*) On emulsion of Danysz bacillus (dilution 1 : 100).
Result: same as on Gärtner emulsion.

* In all experiments the cultures used were 48 hours' gelatine surface cultures. The emulsion was made in each instance in bouillon.

3. Blood of a case suspected to be typhoid fever, tested—

(*a*.) On emulsion of typhoid bacillus (dilution 1 : 100).
Result: clumping commencing in 8 minutes, fairly complete in 15–20 minutes.

(*b*.) On emulsion of Gärtner bacillus (dilution 1 : 100).
Result: negative in one hour.

(*c*.) On emulsion of Danysz bacillus (dilution 1 : 100).
Result: negative in one hour.

4. Blood of a person convalescent from typhoid fever, 55th day of the disease, tested—

(*a*.) On emulsion of typhoid bacillus (dilution 1 : 100).
Result: indication in 10 minutes, practically complete clumping in one hour.

(*b*.) On Gärtner emulsion (dilution 1 : 100).
Result: negative in one hour.

(*c*.) On Danysz emulsion (dilution 1 : 100).
Result: negative in one hour.

5. Blood of a typhoid-immunised guinea-pig, tested—

(*a*.) On typhoid emulsion (dilution 1 : 100).
Result: complete clumping in 10 minutes.

[Same blood on same emulsion (dilution 1 : 200).
Result: complete agglutination in 10–20 minutes.]

(*b*.) On Gärtner emulsion (dilution 1 : 100).
Result: negative in 30 minutes.

(*c*.) On Danysz emulsion (dilution 1 : 100).
Result: negative in 30 minutes.

6. Blood of a typhoid-immunised guinea-pig, tested—

(*a*.) On typhoid emulsion (dilution 1 : 100).
Result: distinct indication of clumping in 10 minutes, practically complete clumping in 30 minutes.

(*b*.) On Gärtner emulsion (dilution 1 : 100).
Result: negative in 45 minutes ; ditto in one hour.

(*c*.) On Danysz emulsion (dilution 1 : 100).
Result: quite negative in 45 minutes, as also in one hour.

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7. Blood of a boy W. W., aet. 10½ years, 16th day of typhoid fever, tested—

(*a.*) On typhoid emulsion (dilution 1 : 100).

Result : complete agglutination in 15 minutes.

[Same blood on same emulsion (dilution 1 : 400).

Result : distinct clumping within 20 minutes.]

(*b.*) On Gärtner emulsion (dilution 1 : 100).

Result : good clumping in five minutes; practically complete in 12 minutes.

[Same blood on same emulsion (dilution 1 : 400).

Result : indication of clumping in 10 minutes; partial clumping in one hour.]

8. Same blood of W. W. nine days later, temperature having been normal for eight days, tested—

(*a.*) On typhoid emulsion (dilution 1 : 400).

Result : practically complete agglutination in 20 minutes.

[Same blood on same emulsion (dilution 1 : 800).

Result : fair partial clumping in 45 minutes.]

(*b.*) Gärtner emulsion (dilution 1 : 400).

Result : indication of clumping in 15 minutes, slight partial clumping in one hour; *i.e.*, few clumps of fair size, but many other bacilli remaining isolated.

[In dilution of 1 : 800, quite negative in one hour.]

(*c.*) On Danysz emulsion, same result as with Gärtner.

9. Blood of a typhoid fever case (atypical), tested—

(*a.*) On typhoid emulsion (dilution 1 : 100).

Result : feeble indication in 30 minutes, a little better in 45 minutes.

(*b.*) On Gärtner emulsion (dilution 1 : 100).

Result : quite negative in one hour.

(*c.*) On Danysz emulsion (dilution 1 : 100).

Result : the same as with Gärtner.

10. Blood of an atypical case of typhoid fever, tested—

(*a.*) On typhoid emulsion (dilution 1 : 20).

Result : feeble indication in one hour.

(*b.*) On Gärtner emulsion (dilution 1 : 20).

Result : quite negative in one hour.

11. Blood of an atypical case of typhoid fever, tested—
   (*a.*) On typhoid emulsion (dilution 1 : 50).
      Result: fair partial clumping in one hour.
   (*b.*) On Gärtner emulsion (dilution 1 : 50).
      Result: negative in one hour.
12. Blood of a typhoid-immunised guinea-pig, tested—
   (*a.*) On typhoid emulsion (dilution 1: 100).
      Result: practically complete in 30 minutes.
   (*b.*) On Gärtner emulsion (dilution 1 : 100).
      Result: negative in one hour.
   (*c.*) On Danysz emulsion (dilution 1: 100).
      Result: negative in one hour.

I think that from these 12 cases definite inferences can be safely drawn; and I may add that I have quoted here by no means all the experiments that I have made with typhoid blood. The facts may be summed up thus :—

(1.) In no instance have I come across blood of a typical typhoid fever case, or blood of an atypical case (*i.e.* symptomatically not typical), or blood of a "typhoid-immunised" guinea-pig, which, in its action as regards agglutination on Gärtner bacillus or on Danysz bacillus, could for a moment be compared with its action on the typhoid bacillus; a dilution which (though high) still showed distinctly positive agglutination of the typhoid bacillus showed nothing of the kind on either the Gärtner bacillus or the Danysz bacillus. Take, for instance, the extreme case of the blood of W. W. (case 8), æt. 10½, on the 25th day of illness (convalescent). This, even in dilution of 1 in 800, agglutinated the typhoid bacillus in 45 minutes, whereas on the Gärtner and on the Danysz bacillus its action in this dilution was quite negative in one hour. This result is in complete agreement with that obtained with the blood of "typhoid-immunised" guinea-pigs, *e.g.* experiments 6, 12.

(2.) Similarly when in a certain dilution the typhoid blood did agglutinate (besides the typhoid emulsion) emulsion of Gärtner (and of Danysz), the clumping in such case was less pronounced, and usually took a longer time to accomplish than with the typhoid bacillus.

(3.) These experiments show that testing the blood in high dilutions tends to more trustworthy results from the point of view of diagnosis than testing it in low dilutions. In the former case the re-action is more likely to be decisive for typhoid than for non-typhoid bacilli.

These results, it is seen, are in harmony with those obtained by Durham (l.c.) and by Dr. Horton Smith (Gulstonian lectures).

Series II.

Tests with blood of "Danysz-immunised" guinea-pig.

Experiment 1.—A guinea-pig had been injected on 17th August with a large dose of sterilised culture of Danysz bacillus; and on the 27th of August with a dose of living culture of this bacillus which in a control guinea-pig caused death in 24 hours.

The blood of the "prepared" Danysz guinea-pig was, September 4th, tested :—

(*a.*) On Danysz emulsion (dilution 1 : 50).
Result: distinct agglutination in 5 minutes.

(*b.*) On typhoid emulsion (dilution 1 : 50).
Result: marked agglutination in 25–30 minutes.

(*c.*) On Gärtner emulsion (dilution (1 : 50).
Result: distinct agglutination in 5 minutes.

Experiment 2.—A guinea-pig had been prepared by injection, first of a sterilised "Danysz culture" 17th August; secondly, by injection of living culture August 27th; and, thirdly, by injection of living culture 5th September.

On September 16th its blood serum was tested :—

(*a.*) On Danysz emulsion (dilution 1 : 100).
Result: negative in 1 hour.

On same emulsion (dilution 1 : 50).
Result: distinct (but not complete) clumping in 40 minutes.

(*b.*) On Gärtner emulsion (dilution 1 : 50).
Result: good clumping in 30 minutes.

(*c.*) On typhoid emulsion (dilution 1 : 50).
Result: complete agglutination in 30 minutes.

This is a striking result, inasmuch as the blood of a "Danysz-immunised" guinea-pig agglutinated typhoid emulsion more pronouncedly than its own emulsion.

Experiment 3.—The blood of the same "Danysz-immunised" guinea-pig was tested a week later :—

(*a.*) On Danysz emulsion (dilution 1 : 100).
Result: distinct clumping in 20 minutes.

(*b.*) On Gärtner emulsion (dilution 1 : 100).
Result: distinct clumping in 20 minutes.

(*c.*) On typhoid emulsion (dilution 1 : 100).
Result: distinct clumping in 20 minutes.

The animal's blood had therefore gained in agglutinating power in the course of a week.

Experiment 4.—The blood of the above guinea-pig, after it had been injected, five times in all, with Danysz culture (once with sterilised and four times with living culture), was tested on November 18th :—

(*a.*) On Danysz emulsion (dilution 1 : 100).

Result: good clumping in 20 minutes.

(*b.*) On Gärtner emulsion (dilution 1 : 100).

Result: good clumping in 20 minutes.

(*c.*) On typhoid emulsion (dilution 1 : 100).

Result: a few clumps in 20 minutes.

So that the agglutinating power of this guinea-pig had not been increased though it had been further twice injected with living culture of Danysz bacillus.

Experiment 5.—A guinea-pig was immunised by subcutaneous injection of, first, a sub-fatal dose of living culture, and, secondly, of an otherwise fatal dose of living culture of Danysz bacillus. After lapse of a week from the second injection its blood serum was tested :—

(*a.*) On Danysz emulsion (dilution 1 : 100).

Result: distinct agglutination in 30 minutes.

(*b.*) On Gärtner emulsion (dilution 1 : 100).

Result: distinct agglutination in 30 minutes.

(*c.*) On typhoid emulsion (dilution 1 : 100).

Result: distinct agglutination in 30 minutes.

It appears, then, that the blood of a "Danysz-immunised" guinea-pig possesses the power of agglutinating typhoid bacilli. There can be no question as to this; it had been ascertained in regard of three different animals. These facts, along with the experiments presently to be described, which show a like agglutinating power towards the typhoid bacillus possessed by the blood of "Gärtner-immunised" guinea-pigs, call in question the thesis entertained by Dr. Horton Smith in his Gulstonian lectures. Dr. Horton Smith, p. 73, III. lecture, says :—"Of the presence of the Gärtner agglutinins in the blood in many, though by no means all, cases of typhoid fever, there cannot be any doubt" . . . p. 78 . . . "a condition of affairs which it is impossible to explain upon any other hypothesis except that of a double infection." That is to say, Dr. Horton Smith cannot explain the power shown by typhoid blood in agglutinating equally, and to a high extent both Gärtner and typhoid bacilli, in any way except on the assumption that when this occurs the

blood has derived its property by a double infection of the system of the person supplying it, *i.e.* (1) infection with typhoid bacillus, and (2) infection with Gärtner bacillus. On a parity of reasoning it would follow that every guinea-pig which, having been immunised against the Danysz bacillus, harbours in its blood not only agglutinins for Danysz bacillus but also agglutinins for the typhoid bacillus, must have been subjected to a double infection —(1) with Danysz and (2) with the typhoid bacillus. The guinea-pigs of my experiments most certainly had not been exposed to such double infection, and the insufficiency of this explanation must therefore be patent.

The above difficulty illustrates the unsatisfactoriness of a number of theories which have been put forward during the last few years in matters pertaining to agglutinins, lysins, anti-toxins, anti-bodies of various kinds; theories which have a common basis in that they attempt to explain extremely complex phenomena on insufficient data. In my opinion the time has not yet arrived for a satisfactory explanation of agglutinins, their nature, production, and mode of action; many of the explanations hitherto brought forward being obviously insufficient. To mention only one: when the agglutination was first noticed on the cholera vibrio and the typhoid bacillus—both motile microbes—the explanation offered was that the agglutinins in the blood of a cholera or of a typhoid immunised animal arrest the ciliary movement of the microbe by making the cilia swell up, and causing thereby a stickiness of the bacilli and vibrios respectively. But it was very soon shown that the same agglutination occurs also under particular conditions with non-motile bacteria, nay, even with dead, *i.e.* previously killed bacteria.

This consideration suffices to emphasise the fact that the more one works in this subject, viz. agglutination, the stronger the conviction that no one theory hitherto offered is capable of explaining all the phenomena observed.

Series III.

Tests with blood of "Gärtner-immunised" guinea-pigs.

I have already mentioned that as regards morphology, motility, cultural characters, and virulence for rodents, the two microbes, Danysz bacillus and Gärtner bacillus, are very closely related; and also that guinea-pigs immunised against one of these microbes are found immunised against the other. It will, therefore, not have been surprising to find (see preceding experiments, Series II.) that the agglutinating power of the blood of a "Danysz-immunised" guinea-pig acts in like fashion toward Danysz bacillus and the Gärtner bacillus. In the present Series III. some experiments made with the blood of "Gärtner-immunised" guinea-pigs afford striking results of a similar import.

Experiment 1.—A guinea-pig had been (October 10th) injected subcutaneously in the groin with living broth culture of Gärtner bacillus. The animal became very ill and developed a big tumour in the groin and abdomen. This tumour became an abscess which opened and discharged pus copiously. Nine days later the abscess had commenced to heal. The blood of the animal was then tested :—

(*a.*) On Gärtner emulsion (dilution 1 : 200).

Result : marked agglutination in 20 minutes, good partial clumping in 1 hour.

(*b.*) On Danysz emulsion (dilution 1 : 200).

Result: marked clumping in 5 minutes, good partial clumping in 1 hour.

(*c.*) On typhoid emulsion (dilution 1 : 200).

Result: feeble indication in 45 minutes.

On same emulsion (dilution 1 : 100).

Result: marked indication in 10 minutes, fair partial clumping in 1 hour.

Experiment 2.—The blood of the companion of the previous (Gärtner) guinea-pig—*i.e.* injected at the same time and with the same material—was tested a week later, the abdominal ulcer having nearly healed up :—

(*a.*) On Gärtner emulsion (dilution 1 : 200).

Result: pronounced partial clumping in 30 minutes.

(*b.*) On Danysz emulsion (dilution 1 : 200).

Result: pronounced partial clumping in 25 minutes.

(*c.*) On typhoid emulsion (dilution 1 : 200).

Result: feeble indication in 1 hour.

On same emulsion (dilution 1 : 100).

Result: fair partial clumping in 1 hour.

Experiment 3.—The blood of the same animal was tested a week later :—

(*a.*) On Gärtner emulsion (dilution 1 : 200).

Result: fair partial clumping in 30 minutes.

(*b.*) On typhoid emulsion (dilution 1 : 100).

Result: marked clumping in 10 minutes, almost complete in 30 minutes.

There is seen then in this series a similar striking phenomenon, viz., the power of the blood of a "Gärtner-immunised" guinea-pig to agglutinate the typhoid bacillus. It is true that the action of this blood was in high dilution less vigorous towards the typhoid bacillus than towards the Gärtner (its own) bacillus; but it is nevertheless sufficiently pronounced, as pronounced indeed as was the agglutination of Gärtner bacillus by the blood of a "typhoid-immunised" guinea-pig.

I do not think that my guinea-pigs, which have been immunised against the Gärtner bacillus, can in the remotest degree have been infected also with the typhoid bacillus.

No. 6.

REPORT on INOCULATION of SOIL with SEWAGE; by Dr. A. C. HOUSTON.

APP. B, No. 6. On the Inoculation of Soil with Sewage by Dr. Houston.

(*Plate XIII.; Figures 1–3.*)

Work in this connection in 1901-2 is an extension of similar investigation carried out during 1900–1 (App. B, No. 4). It is convenient therefore in describing the main object of the experiments to reproduce the introductory remarks of my previous report as follows :—

The main object of these experiments was to ascertain whether in the surface layers of soil after it had been inoculated with sewage, certain microbes peculiar to sewage, or which are at all events characteristic of sewage in the sense of being specially abundant therein, retain their vitality for any considerable length of time. In brief, it was sought to determine the ultimate fate of such sewage microbes as B. coli, streptococci, and spores of B. enteritidis sporogenes, when sown broadcast on soil.

In a previous report it was pointed out that the difficulties attending the isolation of the typhoid fever bacillus from unsterilised soil, even after its addition thereto in gross amount, were of an almost insuperable character. And it was suggested that as the typhoid bacillus is practically always associated with other intestinal microbes much more easily isolated and identified, search in soil for these more readily identifiable bacteria might indirectly be of service in giving information of the probable fate therein of the pathogenic enteric fever bacillus under parallel conditions.

It will be generally admitted that sewage is apt to be concerned in the dissemination of typhoid fever, and it is well known that sewage contains B. coli (and allied forms) in great abundance. Now, B. coli is most certainly a more hardy germ than B. typhosus; that is, more hardy under all the conditions to which it is possible to subject these bacteria in the laboratory. Of course it is conceivable that in nature conditions may arise which are more favourable to the typhoid bacillus than B. coli. But at present all the available evidence points to the improbability of B. typhosus surviving under conditions destructive to the vitality of B. coli. It is evident that, if it could be proved that B. coli perished in soil, the presumption in favour of the death also of the typhoid bacillus would be of a strong kind. A similar inference might reasonably be drawn as regards the fate of the cholera vibrio, and possibly other non-sporing microbes of pathogenic sort. It is known that sewage specifically contaminated with the excreta of enteric fever or of cholera patients can, when gaining entrance into a water supply, give rise to typhoid fever and cholera, and it seems reasonable to conjecture that other diseases may be spread by means of sewage polluted waters.

An inquiry, therefore, which seeks to trace the ultimate fate of sewage microbes, when sewage is artificially added in large amount to a soil, must be regarded as one likely not only to yield direct information of a useful kind, but indirectly to give indications as to the probability or possibility of human disease germs maintaining their existence saprophytically under parallel conditions.

Already I have furnished some information bearing more or less directly on this subject. Thus, in previous reports I have pointed out that soils obtained from diverse sources all contain a very large number of spores of bacteria (both actually and relatively to the total bacterial flora); and I have even ventured to adduce this fact, tentatively, as basis for belief that soil is unfavourable to the vitality of non-sporing bacteria, particularly those of pathogenic sort. On the other hand, although the number of bacteria present as spores in soil is very great many non-sporing microbes (*e.g.*, the fluorescent bacilli) are commonly if not habitually, present also in soil. And it may well be the case that although the general tendency of non-sporing bacteria is to perish in soil, the different races of these microbes escape total extermination because (perhaps at the period of lowest ebb in their life history) some favourable condition supervenes, allowing of a recrudescence of their vitality and the growth of abundant progeny. Thus,

it may be conjectured that bright sunshine and dry winds rapidly diminish the number of non-sporing microbes in soils at or near the surface; but that previous to their total extermination a supervening period of damp and warm weather, with absence of sunshine, allows the living germs still persisting to reproduce their kind and so reassert their vitality. But however true this may be as regards certain non-sporing microbes which normally exist under saprophytic conditions, and which are not very particular as regards their nourishment, it may be remote from the truth as regards other and like germs, particularly those of pathogenic sort. Thus, I have shown that although B. prodigiosus survived 158 days in soil ("in rure") the exotic cholera vibrio seemingly perished in the same soil and under parallel conditions in a few days.

Again, although B. coli is present in extraordinary numbers in excremental matters, and notwithstanding that these substances have a wide distribution in nature, I have found B. coli to be *relatively* absent from surface soils other than those *recently* contaminated with substances of intestinal origin. This would seem to afford reasonable ground for believing in the ultimate extinction of pathogenic non-sporing germs, as for example the typhoid bacillus, in the case of soils specifically contaminated.

The microbes to which, as has been said, special attention was directed during the progress of this enquiry were Streptococci, B. coli (and closely allied forms), and B. enteritidis sporogenes.

So far as could be judged from my previous observations (soil and water report), the presence of at all events some sorts of streptococci points to extremely recent contamination with matters of intestinal outcome, and the presence of B. coli to animal pollution of comparatively recent sort. As regards the spores of B. enteritidis sporogenes, their presence does not necessarily imply pollution of recent date.

It was therefore to be anticipated that in the case of soils artificially contaminated with sewage the streptococci would rapidly disappear; that later, B. coli would no longer be capable of demonstration; but that the spores of B. enteritidis sporogenes would persist as a more or less permanent record of pollution having taken place.

On the whole, although in some directions they were inconclusive, the results of last year's work (1900–1901) went to confirm the truth of the above provisional inferences. The following is a brief summary of the chief results then obtained.

Sewage bacteria versus *soil microbes.*—There was no indication that the addition of sewage to a soil leads to a marked or indeed to other than temporary increase of the sewage microbes in general at the expense of the soil bacteria. On the contrary, the more hardy soil bacteria seemed to oust the more delicate sewage microbes in the struggle for existence.

Gas-forming bacteria.—The addition of sewage to a soil leads to an increase in the number of "*gas-forming*" bacteria. But sometimes rapidly, sometimes more slowly, this increase wholly or in great measure disappears. Occasionally a seeming recrudescence of vitality of the gas-forming bacteria takes place.

Indol-producing bacteria.—The addition of sewage to a soil leads to an increase in the number of *indol-producing* bacteria. This increase, however, tends to be soon lost or is only maintained in a diminished degree. Periods of seeming recrudescence of vitality among these indol-producing bacteria would seem to be indicated.

Spores of B. enteritidis sporogenes.—The soils of experiment were already so rich in the spores of this anaërobe that the inoculation with sewage did not so materially increase their number as to make it easy to trace their ultimate fate in the soil. *Prima facie*, it might be contended that the spores of an anaërobe would neither multiply nor diminish in the surface layers of soil, but remain as a record of past pollution during a period of months or even years. To some extent these experiments confirmed this view, but sometimes the results seemed to indicate a partial disappearance of the spores of B. enteritidis sporogenes from the soil.

B. coli and allied forms.—The addition of sewage to a soil greatly alters its bacterial composition in respect of *B. coli and allied forms.* But this alteration tends to become less and less apparent as time goes on. Sometimes the relative disappearance of B. coli is rapid, sometimes much more slow, and periods of

a seeming return to vitality are not uncommon. Moreover, the total disappearance of microbes seemingly akin to B. coli was by no means always established, even when the period of scrutiny was extended over weeks and even months. But there can be little doubt that the experiments as a whole tend to confirm my previous inferences, namely, that if B. coli does not perish in the surface layers of soil it, at all events, becomes greatly reduced in numbers there; so that its presence in a soil in any number may be taken as affording reasonable grounds for suspecting pollution of *comparatively recent* sort.

Streptococci.—The addition of sewage to a soil may be detected by the presence of streptococci even in a minimal amount of the soil thus polluted. But their disappearance (relatively if not actually) seems to be rapid. Nevertheless, in some instances streptococci, albeit of a somewhat peculiar type, were isolated a considerable time after the inoculation of the soil with the sewage had ceased. The experiments, as a whole, went to confirm the views I have previously expressed, namely, that the presence of streptococci in a soil points to extremely *recent* contamination.

The following is a summary of this contents of this Report:—

A. Bacteriological methods adopted in the investigations.

Part I. (*old* plot) } Inoculation of soil "in rure" with
Part II. (*new* plot) } cesspool sewage.

B. General summary and inferences as regards soil investigation carried out during 1900–1901 and 1901–1902.

C. Table of Meteorological observations.

[The tables are brought into the text in appropriate order, and the corresponding diagrams as near them as possible.]

A. Bacteriological Methods adopted in the Investigation.

The following is a brief account of the methods used throughout the investigation:—

Collection of samples.—The samples of soil were collected in sterile tins. A sterile tin scoop was used to transfer the surface layers of the soil to the tins.

Dilution of the samples.—The samples of soil were diluted with sterile water as follows: To each of six small conical flasks (labelled in sequence (1), (2), (3), (4), (5), (6)), 90 cc. of distilled water were added. The flasks were plugged with cotton wool and sterilised in the usual way. Ten grammes of the soil were weighed out into a sterile watch glass and transferred from the watch glass with a suitable sterile instrument into flask (1). A sterilised glass rod with a flattened end was used to bruise and intimately to mix the soil and water. After allowing five minutes to elapse, so as to allow the grosser particles to settle, 10 cc. of the surface liquid were withdrawn by means of a sterilised pipette and added to the second flask (2). After shaking, 10 cc. of (2) were withdrawn by means of a sterile pipette and added to the third flask (3). In the same manner the fourth flask (4) was inoculated from flask (3), the fifth flask (5) from flask (4), and finally the sixth flask (6) from flask (5).

Total number of bacteria (gelatine at 20° C.).—The number of bacteria was estimated in Part 2, but not in Part I. Gelatine plate cultures were made in the usual way, and commonly 1 cc. respectively of (3), (4) and (5) dilutions were used. Sometimes plates were made from the (2) and (6) dilutions as well.

"*Gas*" *in gelatine* "*shake*" *cultures* (24 hours at 20° C.).—The "gas" test was used in Part 2, but not in Part I. Tubes containing 10 cc. of sterile gelatine were inoculated with 1 cc. from the different dilutions. The tubes were placed in warm water (about 40° C.) for a few minutes, shaken, placed in cold water until the gelatine had solidified, and then incubated at 20° C. In 24 hours they were examined for "gas" production. Gas-forming bacteria are peculiarly

abundant in sewage, and they belong chiefly to the B. coli and B. proteus class. $\frac{1}{100}$ to $\frac{1}{1000}$ cc. of crude sewage is almost invariably sufficient to produce "gas" in gelatine "shake" cultures in 24 hours at 20° C. Virgin soils and pure waters usually yield negative results with this test, even when comparatively large quantities of these substances are used. It was hoped that this "gas" test might yield useful results in the present investigation.

Spores of B. enteritidis sporogenes (Klein's "enteritidis change" in anaërobic milk cultures).—A series of sterile milk tubes was inoculated severally with 1 cc. of (2), (3), (4), and (5) dilutions of the soil. These tubes were then heated to 80° C. for ten minutes and cultivated under anaërobic conditions at a temperature of 37° C.

B. coli (and closely allied forms).—The primary broth and subsequent surface gelatine plate culture method was used. The colonies, which appearing in the plate cultures bore any resemblance to B. coli, were sub-cultured in broth (for diffuse cloudiness and indol formation), in litmus milk (for acidity and clotting), in gelatine ("shake" cultures for "gas" formation), and in neutral red broth (for greenish yellow fluorescence). As regards the broth cultures 1 cc. of dilutions (2), (3), (4), and (5) was employed.

Streptococci.—Surface agar plate cultures were used. These were usually inoculated with 0·1 cc. of dilutions (2), (3), (4) and incubated at 37° C. for 24–48 hours. Minute colonies resembling streptococci were sub-cultured in broth for further examination and incubated at 37° C. If on microscopic examination, the growth in these broth cultures appeared to be that of a streptococcus, the microbe was further studied in agar, gelatine, and milk cultures.

PART I.—(OLD PLOT).

Inoculation of soil "in rure" with cesspool sewage.

The plot of ground chosen for the experiments was the same as that used last year (1900–1901). It is situated about twelve miles from London, on a private estate.*

The soil was originally dredged (about thirteen years ago) from the bed of a stream and deposited on marshy ground adjoining this stream. Although at one time believed to have been manured, no manure or other "dressing" had been applied to it for at least six years. The plot of ground is sheltered to some extent by adjacent trees and shrubs from the effects of the wind, and during certain hours of the day from the direct rays of the sun.

After weeding and gently raking over the soil, an area was marked out (in the same position as last year), with pegs and stout string, measuring 5′ × 5′. This area was further subdivided into sixteen equal divisions (15″ × 15″). The dimensions, &c. of the plot are shewn in Diagram 1.

It will be remembered that in July, 1900, the plot was watered equally all over with twelve gallons of cesspool sewage (Part 1, Series 2). The biological composition of this sewage was as follows:—B. coli (typical in all respects) present in $\frac{1}{10000}$ cc., streptococci present in $\frac{1}{1000}$ cc., spores of B. enteritidis sporogenes present in ·01 but not ·001 cc.; $\frac{1}{100}$ but not $\frac{1}{1000}$ cc. of this sewage yielded gas in gelatine "shake" cultures in 24 hours at 20° C. The total number of bacteria and spores of aërobic bacteria was 1,970,000 and 160 respectively per cc.

* By the lamented death of Mr. Smee I have lost a friend who took an active interest in my investigations and who year after year placed his land at my disposal for carrying out these experiments.

Further, from August 13th to September 22nd (both dates inclusive) the same plot was watered bi-weekly with 12 gallons of the cesspool sewage (Part I., Series 2). In one week, however, the plot was only watered once, and on more than one occasion the soil would not soak up the whole of the sewage. On these occasions as much was put on as the land could absorb. A final watering (12 gallons) was made on September 24th. At a minimal estimate, at least 96 gallons of cesspool sewage were applied to the soil during the above period.

Lastly, during part of December, 1900, and during January and part of February, 1901, about 90 gallons of cesspool sewage were intermittently applied equally all over the same plot of land (Part I., Series 3).

So that altogether during the period July, 1900, to February, 1901 (both months inclusive) about 200 gallons of sewage had been intermittently applied to the same plot of land. 200 gallons of sewage is equivalent to more than 900,000 cc. The result as regards the bacterial composition of the cesspool sewage given in a previous paragraph must therefore be multiplied nine hundred thousand times to represent the bacterial contamination of the soil. Nevertheless it must be remembered that during the period under review as also subsequently samples of the surface layers of soil were being periodically removed for bacteriological investigation.

The soil (*see* Diagram 1) was watered equally all over with 6 gallons of cesspool sewage on the following dates:—August 7th, 10th, 12th, 14th, 15th, 18th, 20th, 25th, 28th; September 2nd, 4th, 6th, 11th, 12th, 1901. The total amount thus intermittently applied was 84 gallons.* The dates of collection of the various samples of soil were as follows:—

September 12th, 1901.	Sample	I.	(immediately after last application of sewage).
September 17th, 1901.	Sample	II.	(5 days later).
September 25th, 1901.	Sample	III.	(13 days later).
October 1st, 1901.	Sample	IV.	(29 days later).
October 8th, 1901.	Sample	V.	(26 days later).
October 15th, 1901.	Sample	VI.	(33 days later).
October 29th, 1901.	Sample	VII.	(47 days later).
November 19th, 1901.	Sample	VIII.	(68 days later).
December 4th, 1901.	Sample	IX.	(83 days later).
December 18th, 1901.	Sample	X.	(97 days later).
January 14th, 1902.	Sample	XI.	(124 days later).
February 4th, 1902.	Sample	XII.	(145 days later).

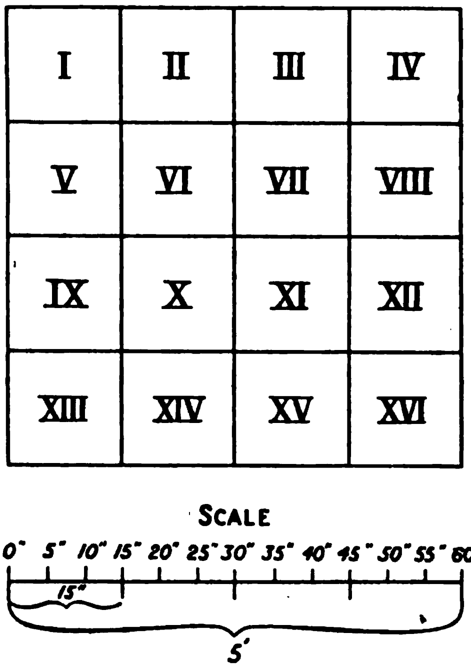
* Taking into account last year's inoculations, this means that during the period July, 1900, to September 12th (inclusive), 1901, 284 gallons, or about 1,278,000 cc. had been intermittently applied to a plot of land measuring 5 × 5′.

DIAGRAM 1.

APP. B, No. 6.

On the Inoculation of Soil with Sewage; by Dr. Houston.

Showing the *old* plot of land used in the Autumn of 1901 for further soil inoculations (Part I.). The soil was inoculated with six gallons of cesspool sewage on the following dates:—August 7th, 10th, 12th, 14th, 15th, 18th, 20th, 25th, 28th; September 2nd, 4th, 6th, 11th, 12th, 1901. Total amount, 84 gallons.



September 12th, 1901.	Sample	I.	(collected immediately after the last inoculation of the soil with six gallons of cesspool sewage
September 17th, 1901.	Sample	II.	(5 days later).
September 25th, 1901.	Sample	III.	(13 days later).
October 1st, 1901.	Sample	IV.	(19 days later).
October 8th, 1901.	Sample	V.	(26 days later).
October 15th, 1901.	Sample	VI.	(33 days later).
October 29th, 1901.	Sample	VII.	(47 days later).
November 19th, 1901.	Sample	VIII.	(68 days later).
December 4th, 1901.	Sample	IX.	(83 days later).
December 18th, 1901.	Sample	X.	(97 days later).
January 14th, 1902.	Sample	XI.	(124 days later).
February 4th, 1902.	Sample	XII.	(145 days later).
March 5th, 1902.	Sample	XIII.	(174 days later).
March 17th, 1902.	Sample	XIV.	(186 days later).
March 24th, 1902.	Sample	XV.	(193 days later).
April 3rd, 1902.	Sample	XVI.	(203 days later).

March 5th, 1902. Sample XIII. (174 days later).
March 17th, 1902. Sample XIV. (186 days later).
March 24th, 1902. Sample XV. (193 days later).
April 3rd, 1902. Sample XVI. (203 days later).

The following is an account of the results of the examination of the various samples of soil, under :—

1. B. enteritidis sporogenes.
2. B. coli.
3. Streptococci.
4. General summary.

1. *B. ENTERITIDIS SPOROGENES* (Klein's "enteritidis change" in anaërobic milk cultures). The results obtained by the use of the above test are shown in Table I. and Diagram 2.

TABLE I.

Showing, as regards the number of spores of B. ENTERITIDIS SPOROGENES (Klein's "enteritidis change" in anaërobic milk cultures), the results of the Bacteriological Examination of Soils I. to XVI.

[Part I.]

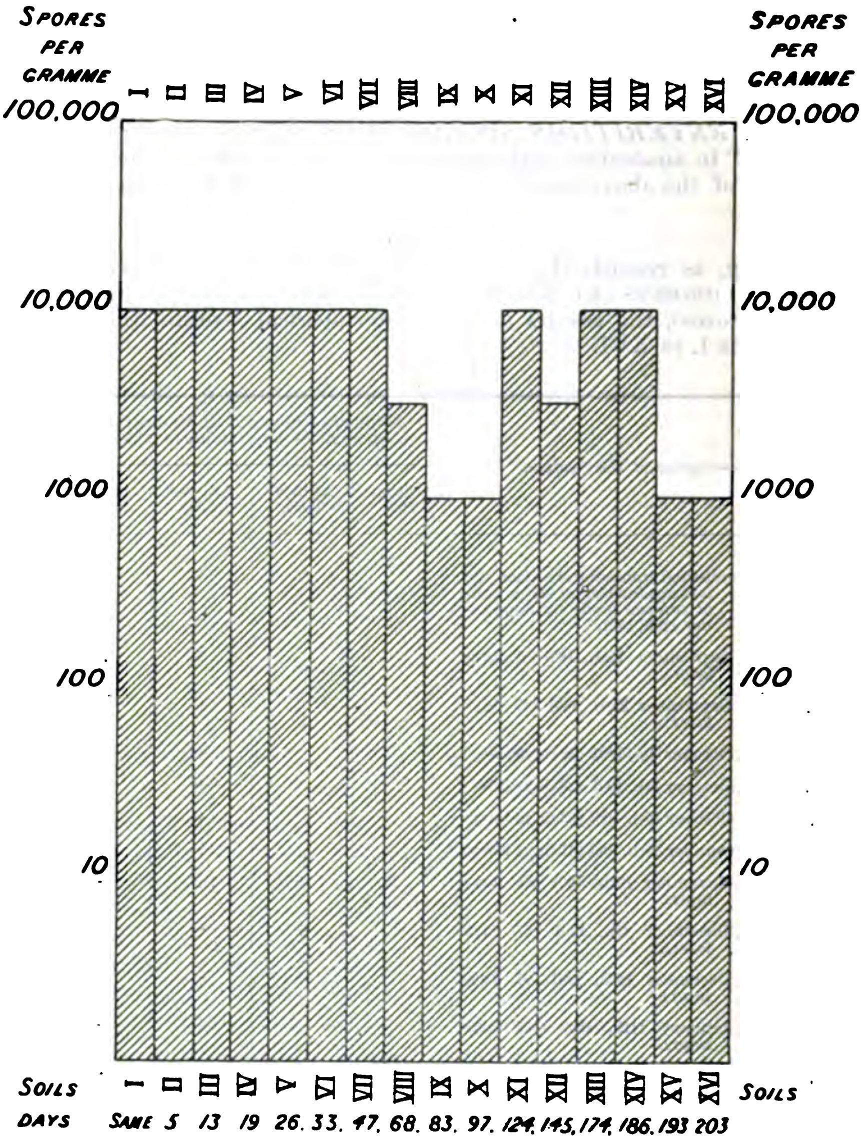
Description of the Sample.	Number of Spores of B. Enteritidis Sporogenes per gramme of Soil.			
	At least 100.	At least 1,000.	At least 10,000.	At least 100,000.
Soil I., collected immediately after the last application of six gallons of sewage made on September 12th, 1901.			+	-
" II., September 17th, 1901 (5 days later).			+	-
" III., September 25th, 1901 (13 days later).			+	-
" IV., October 1st, 1901 (19 days later)			+	-
" V., October 8th, 1901 (26 days later)			+	-
" VI., October 15th, 1901 (33 days later)			+	-
" VII., October 29th, 1901 (47 days later)			+	-
" VIII., November 19th, 1901 (68 days later).		+	?+	-
" IX., December 4th, 1901 (83 days later).		+	-	
" X., December 18th, 1901 (97 days later).		+	-	
" XI., January 14th, 1902 (124 days later).			+	-
" XII., February 4th, 1902 (145 days later).		+	?+	-
" XIII., March 5th, 1902 (174 days later)			+	-
" XIV., March 17th, 1902 (186 days later)			+	-
" XV., March 24th, 1902 (193 days later)		+	-	
" XVI., April 3rd, 1902 (203 days later)..		+	-	

APP. B, No. 6.

On the Inoculation of Soil with Sewage; by Dr. Houston.

DIAGRAM 2.

Showing as regards B. enteritidis sporogenes the results of the bacteriological examination of Soils I. to XVI. Old Plot. Part 1.



It will be seen from the table that Soil I. collected immediately after the last application of sewage gave a positive result with ·0001 gramme. Soils II., III., IV., V., VI., VII. collected respectively 5, 13, 19, 26, 33 and 47 days later all yielded a similar result. Soil VIII. (68th day) gave a doubtfully positive result with ·0001 gramme, and a completely positive with ·001 gramme. Soils IX., X. (83rd and 97th days) gave a positive result with ·001 gramme, but a completely negative result with ·0001 gramme. Soil XI. (124th day) yielded a positive result with ·0001 gramme. Soil XII. (145th day) gave a similar result to Soil VIII. Soils XIII. and XIV. (174th and 186th days) contained as many spores as Soil I., namely, at least 10,000. The last two Samples XV. and XVI. (193rd and 203rd days) reverted to + ·001 — ·0001 gramme (1,000 but less than 10,000).

These results, corroborated to some extent by those of last year, seem to suggest that spores as well as bacilli may possibly gradually undergo dissolution in the surface layers of soil. Of course it may be the case that some of the spores were washed off the surface or into the deeper layers of the soil. But it will be remembered in this connection that in my B. prodigiosus experiments this microbe was isolated from the soil 158 days subsequent to the inoculation process. So that it must not be too hastily inferred that the reduction in the number of spores of B. enteritidis sporogenes is to be *wholly* accounted for in this way. There is also of course the possibility that some of the spores developed into bacilli and perished under the stress of competition with the saprophytic soil microbes. But as B. enteritidis sporogenes is an anaerobe, this seems unlikely. However this may be, the reduction was slight (if not trivial) in comparison with the marked reduction observed as regards the non-sporing B. coli.

2. *B. COLI.**—The results as regards B. coli (and closely allied forms) may be summed up as follows :—

It will be remembered from the Report on last year's work that a "mixed" sample of the soil collected on July 20th, 1901, from all the 16 divisions of the plot contained, so far as could be ascertained by careful examination, no B. coli in 1 gramme of the mixture. So that prior to the inoculations carried out during August and September, 1901, the soil was sterile (or relatively so) so far as B. coli is concerned.

Immediately after the last application of 6 gallons of sewage made on September 12th, 1901 (which with the preceding inoculations carried the total amount newly applied up to 84 gallons) Sample I. was collected. From this point onwards Samples II. to XVI. were collected at irregular intervals, the last Sample (XVI.) being taken 203 days subsequent to the last inoculation with the sewage.

What the result was, as regards B. coli, of the bacteriological examination of these samples, is shown in the table† which follows :—

* It must be remembered that the difficulties in this direction were greatly increased by the fact that there was added to the soil not one strain of B. coli but all the different races of coli-like microbes present in the sewage.

† It is important that Diagram 3 should also be consulted.

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Table 2.

Showing as regards B. coli (and allied forms) the results of the Bacteriological Examination of Soils I. to XVI. Part I., Old Plot.

[Reference should also be made to Diagram 3.]

Sample of soil.	Amount of soil.	Number of microbe.	"Gas" in gelatine "shake" cultures at 20° C. (unless otherwise stated none of the microbes liquefied gelatine within 30 days).	Indol in broth cultures (5 days at 37° C.).	Acidity in litmus milk cultures (5 days at 37° C.).	Acid clot in litmus milk cultures (5 days at 37° C.).	Greenish yellow fluorescence in neutral red broth cultures (5 days at 37° C.).	Marks allotted (of illustrative value only).*	Number of days subsequent to last inoculation.
	Gramme.								
I.	·001	1	+	+	+	+	+	5,000	Same day.
"	·0001	2	+	+	+	+	+	50,000	
"	·00001	3	+	+	+	+	+	500,000	
II.	·001	4	+	-	+	+	+	4,000	5
"	·0001	5	+	-	+	+	+	40,000	
"	·00001	6	+	-	+	+	+	400,000	
III.	·01	7	+	-	+	+	+	400	13
"	·001	8	+	-	+	+	+	4,000	
IV.	·01	9	+	-	+	+	+	400	19
"	·001	10	+	-	+	+	+	4,000	
"	·0001	11	-	As no "gas" not studied further.				0	
V.	·01	12	-	As no "gas" not studied further.				0	26
"	·001	13	+	-	+	-	+	3,000	
"	·0001	14	-	As no "gas" not studied further.				0	

* It must be understood that these marks are allotted for illustrative purposes only. One mark is given for each positive attribute (½ mark when the result was doubtful or the reaction was very slight). The sum of the marks in each case is multiplied one hundred, one thousand, one ten-thousand, one hundred-thousandfold, according to whether the microbe was isolated, from ·01 ; ·001 ; ·0001 ; or ·00001 of a gramme of the sample of soil. No marks are given for a non-gas-producing microbe. Example—Microbe 3 was isolated from ·00001 gramme of Soil I. It gave a positive result with all of the five tests employed. 5 × 100,000 = 500,000 marks. The method of marking is obviously open to criticism. Thus a microbe from a high dilution, but possessed of feeble and few positive characters, and hence possibly only a remote ally of B. coli, ranks higher than a microbe giving a positive response to all the tests employed, but occurring only in a low dilution. But the guarded manner in which I draw inferences from these marks may serve to discount objections of this kind. Moreover, be it noted, the marking method adopted serves to mask rather than exaggerate the point I seek to establish, namely, the decline in the number of B. coli in the soil subsequent to the last inoculation with cesspool sewage.

Table 2—*continued.*

Sample of soil.	Amount of soil.	Number of microbe.	"Gas" in gelatine "shake" cultures at 20° C. [unless otherwise stated none of the microbes liquefied gelatine within 30 days].	Indol in broth cultures (5 days at 37° C.).	Acidity in litmus milk cultures (5 days at 37° C.).	Acid clot in litmus milk cultures (5 days at 37° C.).	Greenish yellow fluorescence in neutral red broth cultures (5 days at 37° C.).	Marks allotted (of illustrative value only).*	Number of days subsequent to last inoculation.
	Gramme.								
VI.	·01	15	+	-	+	+	? +	350	33
"	·001	16	+	-	+	-	? +	2,500	
"	·0001	17	+	-	+	-	? +	25,000	
"	·00001	18	+	-	+	+	? +	35,000	
VII.	·01	19	+	+	+	+	+	500	47
"	·001	20	+	+	+	-	-	3,000	
"	·0001	21	-	As no "gas" not studied further.				0	
"	·00001	22	+ feeble.	-	+ slight.	-	-	100,000	
VIII.	·001	23	+ feeble.	-	+ slight.	-	-	1,000	68
"	·0001	24	-	As no "gas" not studied further.				0	
IX.	·01	25	+	-	+	+	+	400	83
"	·001	26	-	As no "gas" not studied further.				0	
"	·0001	27	+	-	+	-	-	20,000	
X.	·01	28	-	As no "gas" not studied further.				0	97
"	·001	29	-	"	"	"	"	0	
"	·0001	30	-	"	"	"	"	0	
XI.	No colonies resembling B. coli could be found in any of the cultures.							0	124
XII.	·01	31	+	-	+	+	+	400	145
"	·001	32	+	-	+	+	-	3,000	
"	·0001	33	+	-	+	-	-	30,000	
"	·00001	34	-	As no "gas" not studied further.				0	

* See preceding explanatory note.

Table 2—*continued.*

Sample of soil.	Amount of soil.	Number of microbe.	"Gas" in gelatine "shake" cultures at 20° C. [unless otherwise stated none of the microbes liquefied gelatine within 30 days].	Indol in broth culture (5 days at 37 C.).	Acidity in litmus milk cultures (5 days at 37° C.).	Acid clot in litmus milk cultures (5 days at 37° C.).	Greenish yellow fluorescence in neutral red broth cultures (5 days at 37° C.).	Marks allotted (of illustrative value only.)*	Number of days subsequent to last inoculation
	Gramme.								
XIII.	·01	35	-	As no "gas" not studied further.				0	174
„	·001	36	-	„	„	„	„	0	
XIV.	No colonies resembling B. coli could be found in any of the cultures							0	186
XV.	·01	37	-	As no "gas" not studied further.				0	193
„	·001	38	-	„	„	„	„	0	
„	·0001	39	+ very feeble, one bubble.	-	? +	-	-	10,000	
„	·00001	40	-	As no "gas" not studied further.				0	
XVI.	·01	41	-	As no "gas" not studied further.				0	203
„	·001	42	-	„	„	„	„	0	

* See preceding explanatory note.

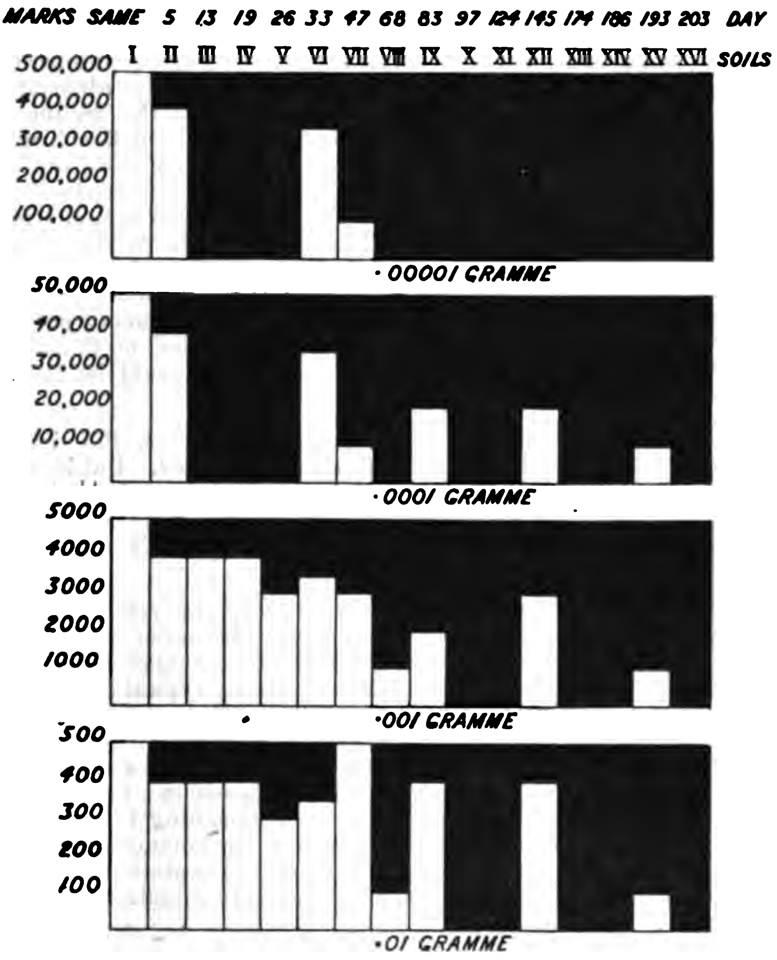
It will be noted that Sample I. contained B. coli in ·00001 gramme, responding to all the five positive tests applied. From this point onwards no B. coli of *entirely* comparable sort were to be obtained in a similar amount of soil, although Soil II. (5 days) and Soil VI. (33 days) contained microbes indubitably belonging to the B. coli class. Soil VII. (47 days) contained a coli-like microbe extremely "weak" in its positive attributes, which might conceivably be attributed to the circumstance of its long separation from the animal body. This, however, is mere conjecture, although my results this year, as did those of last year, seem to point rather in this direction. All the remaining soils, tested in this quantity, yielded a totally negative result as regards B. coli. These results are shown in graphic form in Diagram 3.

As regards the ·0001 gramme cultures, the decline of B. coli is nearly, but not quite, as apparent. Thus in Soils IX. and XII. (83 and 145 days) microbes were found which gave "gas" in

DIAGRAM 3.

Showing the decline in the number of B. coli in the soil subsequent to the last inoculation with cesspool sewage (Part 1 old plot).

[Constructed from table 2.]



When a coli-like microbe was present in a higher dilution (or possessed of a greater number of positive characters in the higher dilution than in the lower dilution), then the lower dilution is credited with also possessing microbes of similar character.

[The black portion represents the decline in the number of B. coli. The white columns show the marks allotted to the various samples of soil as regards their B. coli contents.]

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gelatine "shake" cultures and acidity in litmus milk cultures, although they failed as regards the remaining three tests. And in Soil XV. (193 days) a microbe was found which merited consideration, although its claims to inclusion in the coli group were not of a strong character. Moreover, in the lower dilutions no microbe in any way comparable with B. coli could be found. In this ·0001 gramme series of cultures, as in the ·00001 gramme series, no coli of *completely* positive sort were found in any of the soils, except in the case of Soil I. which was collected immediately after the last application of sewage.

The ·001 gramme series of cultures yielded a greater number of positive results as regards B. coli; but here also the numerical decline in the number of coli-like microbes as also the decline as regards the possession of all the positive attributes of B. coli was well marked. Soils III. and IV. (13 and 19 days) yielded in this dilution B. coli typical* in all respects, save indol production. Soil V. (26 days) also except as regards the indol test and clotting of milk was typical of B. coli. Further Soils VII. (47 days) and XII. (145 days) contained coli of more characteristic sort in the ·001 than in the ·0001 cultures. Soil VIII. (68 days) was possessed of feeble positive characters, and was assigned only 1 out of 5 marks. Here also (as in the ·0001 and ·00001 gramme series) no B. coli of *quite* comparable sort to that isolated from Soil I. could be found in any of the Soils II. to XVI.

As regards the ·01 gramme series of cultures, the death, relatively speaking, of B. coli was also established. But in Soil VII. (47 days) a microbe was found which responded to all the positive tests employed. And in Soils IX. (83 days) and XII. (145 days), the coli microbes were more typical in the ·01 than in the ·001 series of cultures.

The results, as a whole, conclusively prove the *relative* death of B. coli in the soil of experiment. They also seem to indicate that the somewhat atypical members of the coli group persist longer than the strictly typical, or else that the strictly typical forms lose in process of time some of their positive attributes, or retain them only in diminished degree. The latter is an attractive hypothesis, and my results, both this year and last year, would almost seem to lend countenance to such a tentative supposition; yet it must be remembered that there is no proof forthcoming that the *less* typical forms were not in reality present at the commencement of the investigations, but at that period remained neglected owing to the presence in greater abundance of the more completely typical microbes.

3. *STREPTOCOCCI.*—The results as regards streptococci may be briefly described as follows:—

SOIL I.—Streptococci 1 and 2 were isolated from ·001 and ·0001 gramme respectively of the soil (surface agar plate cultures at 37° C.).

* I do not defend the use I make of this term on scientific grounds, but for convenience and brevity of expression; phrases such as the above are with difficulty dispensed with.

SOIL II.—[Microbes 3 and 4] were isolated from ·001 gramme of the soil (surface agar plate cultures at 37° C.). They were finally classed as microbes simulating streptococci but not sufficiently closely to suggest identity with this class of microbes. Sub-cultures were made in addition from ten other minute colonies suspected of being those of streptococci, but the result was in each case negative.

SOIL III., „ IV., „ V., „ VI., „ VII. — No streptococci could be found in ·001* gramme (surface agar plate cultures at 37° C.). To test further the negative evidence as to the presence of streptococci, the minute colonies in the various plates were frequently sub-cultured. In this way 15 colonies were subjected to more or less attentive study. But the result was wholly negative as regards the presence of streptococci.

SOIL VIII.—[? Streptococcus 5] was isolated from ·001 gramme of the soil (surface agar cultures at 37° C.). Its identity with the streptococcus class was doubtful. Subcultures were made in addition from eight other minute colonies suspected of being those of streptococci, but the result was in each case negative.

SOIL IX., „ X., „ XI. — No streptococci could be found in ·001 gramme (surface agar plate cultures at 37° C.). To test further the negative evidence as to streptococci, the minute colonies in the various plates were frequently subcultured. In this way 21 colonies were subjected to more or less attentive study. But the result was wholly negative as regards the presence of streptococci.

SOIL XII.—[? Diplo-bacillus 6] was isolated from ·001 gramme of the soil (surface agar plate cultures at 37° C.). The identity of this microbe was doubtful but it could not be classed as a streptococcus. Subcultures were made in addition from nine other minute colonies suspected of being streptococci, but the result was in each case negative.

SOIL XIII., „ XIV., „ XV., „ XVI. — No streptococci could be found in ·001 gramme (surface agar plate cultures at 37° C.). To test the negative evidence as to streptococci, the minute colonies in the various plates were frequently subcultured. In this way 38 colonies were subjected to more or less attentive study. But the result was wholly negative as regards the presence of streptococci.

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* It needs to be explained that a larger amount of soil than ·001 gramme could not conveniently be used owing to the presence in soil of an enormous number of bacteria capable of growing in agar at 37° C. Even when using ·001 gramme it was necessary to distribute the material over a number of plates to avoid overcrowding.

These results can only be interpreted as meaning the relative, if not the absolute, death of the streptococci which, by means of the sewage inoculations, had been artificially added to the soil. Moreover, if we exclude microbes 3, 4, 5, and 6, as only doubtfully, if at all, streptococci, then it may be said that the decline in the soil of the number of the sewage streptococci originally added was extremely rapid. It may, however, be pointed out that it has never been contended that *all kinds* of streptococci are necessarily of feeble vitality, nor that as regards streptococci or B. coli "apparent death" is synonymous with "total extinction." In these matters I am careful now, as in the past, to forbear drawing conclusions otherwise than from the results obtained when working with a stated and definite amount of soil.

The following is a brief account of the chief morphological and biological characters of the streptococci (or microbes suspected of being streptococci) above referred to :—

Streptococcus 1, isolated from ·001 gramme (agar plate cultures at 37° C.) of Soil I.

Morphology.—* Chains of cocci of medium length unquestionably a streptococcus.

Gelatine streak cultures (20° C.).—Colonies extremely minute and transparent looking. No liquefaction of the gelatine occurs.

Broth cultures (37° C.).—Diffuse cloudiness; but on sides and foot of tube cirrhus-like growth.

Litmus milk cultures (37° C.).—Strong acid and solid clot within two days.

Remarks.—Two mice were subcutaneously inoculated each with 1½ cc. of a mixed broth and serum culture. One died on the 8th day, the other on the 9th day. Cultures made post mortem from the spleen and kidney of each animal yielded B. coli and no streptococci could be found.

Streptococcus 2, isolated from ·0001 gramme (agar plate cultures at 37° C.) of Soil I

Morphology.—* Chains of cocci of medium length, unquestionably a streptococcus.

Gelatine streak cultures (20° C.).—Colonies extremely minute and transparent looking. No liquefaction of the gelatine occurs.

Broth cultures (37° C.).—Diffuse cloudiness, but on sides and foot of tube cirrhus-like growth.

Litmus milk cultures (37° C).—Strong acid and solid clot within two days.

Remarks.—Non-pathogenic to mice.

[*Microbe* 3] isolated from ·001 gramme (agar plate cultures at 37° C.) of Soil II.

Morphology.—Appeared to be a short bacillus occurring in chains, thus simulating a streptococcus.

Gelatine streak cultures (20° C.).—The colonies were separate fairly small and transparent looking, although much larger than the colonies of streptococci 1 and 2.

Broth cultures (37° C.).—Uniform turbidity.

Litmus milk cultures (37° C.).—Acidity and, by 2nd day, clot.

Remarks.—The microbe was finally classed as a small bacillus simulating both morphologically and biologically a streptococcus.

[*Microbe* 4] isolated from ·001 gramme (agar plate cultures at 37° C.). of Soil II.

Morphology.—Irregularly shaped elements (? cocci) occuring chiefly in little clusters and not as chains.

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* *See* figure . Plate .

Agar streak cultures (37° C.).—Growth abundant opaque and quite unlike a streptococcus.

Broth cultures (37° C.).—Diffuse but not abundant cloudiness.

Remarks.—Although at first suspected of being a streptococcus, its further study removed this original impression.

[? *Streptococcus* 5] isolated from 0·001 gramme (agar plate cultures at 37° C.) of Soil VIII.

Morphology.—In broth cultures, it seemed almost without doubt to be a streptococcus; but an examination of an agar culture left the matter in much doubt. Here it appeared as clumps of irregularly shaped cocci with occasional chains.

Gelatine streak cultures (20° C.).—No growth occurred even after one week's incubation.

Agar streak cultures (37° C.),—Here growth was readily obtained and indeed the colonies seemed rather too large and opaque for a streptococcus.

Broth cultures (37° C.).—Slight diffuse cloudiness, "stringy" deposit at foot of tube.

Litmus milk cultures (37° C.).—Little or no change within one week.

Remarks.—The identity of this microbe with the streptococcus class was left in much doubt; obviously, however, the microbe bore no resemblance to streptococci 1 and 2 isolated from Soil I.

[? *Diplo-bacillus* 6] isolated from ·001 gramme (agar plate cultures at 37° C.) of Soil XII.

Morphology.—In broth cultures the microbe seemed to be diplo-coccus or a diplo-bacillus. In agar and gelatine cultures, it appeared to grow as a coccus (? short bacillus) occurring singly, in couples, and as masses of ? cocci. No definite chain formation.

Gelatine (20° C.) and *Agar* (37° C.) *streak cultures.*—The growth on these media was not unlike that of a streptococcus, the colonies being small and transparent looking.

Broth cultures (37° C.).—Diffuse but not very abundant cloudiness.

Litmus milk cultures (37° C.).—Slight acid but no clot.

Remark.—On the whole perhaps best considered a coccus (? short bacillus) simulating a streptococcus.

It may be a point of importance that streptococci 1 and 2 isolated from Soil I. produced acid clotting of milk cultured within two days, whereas none of the microbes subsequently isolated, with the exception of microbe 3, was able to clot milk.

Summary of Part I.

4. The following is a *general summary* of the results obtained in Part I. of the inquiry:—

Spores of B. enteritidis sporogenes.—This year (1901–1902), as in last year's work (1900–1901), there was some indication of a decline in the number of spores of this anaërobe during the period the soil was kept under observation. But as Soils XI. (124 days), XIII. (174 days), and XIV. (186 days) yielded the same results as Soil I. (collected immediately after the final inoculation with sewage) too much stress must not be laid on this circumstance. Indeed, the apparent decline in the number of B. enteritidis sporogenes, when compared with the results as regards B. coli and streptococci, may seem hardly worth special mention.

B. coli and allied forms.—This year's work (1901–1902) perhaps even more than that of last year (1900–1901) served to show that the more typical strains of B. coli rapidly diminish in number in soil when the artificial pollution of such soil with excremental matter is discontinued. Further, that the less typical forms (originally atypical or atypical by loss of positive attributes previously possessed) seemed to persist much longer than the more typical races of B. coli. The *relative* death of B. coli (and its close allies) was then clearly established, and if the microbe doubtfully B. coli isolated from Soil XV. be neglected, then it may be stated that while Soil I. (collected the same day as the last inoculation) contained completely typical B. coli in $\frac{1}{100000}$ gramme, Soils XIII. (174 days), XIV. (186 days), XV. (193 days), XVI. (203 days), contained no coli-like microbes of any sort even in $\frac{1}{100}$ gramme. But it must also be remembered that soil may permit retention of vitality in *certain strains* of B. coli during a period covered by some weeks, if not months.

Streptococci (agar at 37° C.)—It is to be noted that streptococci 1 and 2 were isolated respectively from ·001 and ·0001 gramme of Soil I. (collected immediately after the final inoculation with sewage). In none of the remaining fifteen samples of soil could any microbes of *comparable* sort be found. But in Soils II., VIII., and XII. bacteria were found bearing a greater or less resemblance to streptococci. That the streptococci present in the cesspool sewage perished (*relatively speaking*) in the surface layers of soil seems hardly open to question.

PART II.—(NEW PLOT.)

Inoculation of soil "in rure" with cesspool sewage.

A sharp distinction must be drawn between Part I. and Part II. of this investigation. In Part I. a garden soil (formerly cultivated) was being dealt with, whereas in Part II. the soil was one of great bacterial purity and was moreover artificially laid down to meet the requirements of the investigation.

The soil (Thanet sand) was obtained from a quarry in the neighbourhood and was laid down as follows:—

A plot of ground not far distant from that dealt with in Part I. was selected and a space dug out of such a size and depth as to enclose a wooden frame 4 feet long, 3 feet broad and 8 inches deep (2 inches of the frame being allowed to project above the surface of the surrounding soil). Into the vacant space (4′ × 3′ × 6″) Thanet sand was filled in with a spade to the level of the surrounding soil. By means of nails and string the artificial plot thus formed was divided up into 12 equal divisions each 1 foot square. A glance at diagram 4 will render this description at once intelligible.

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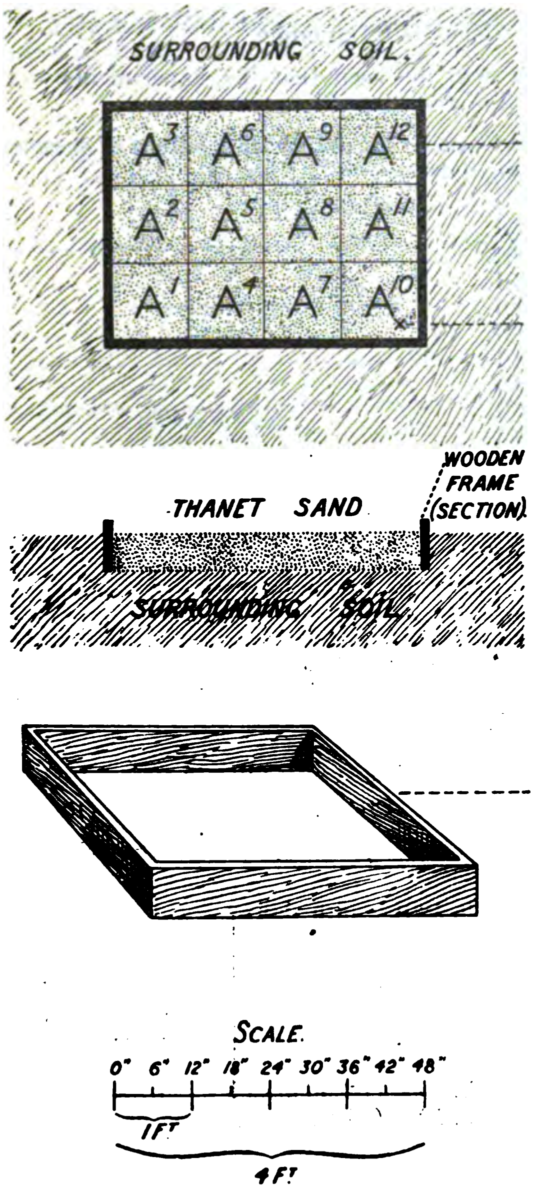
DIAGRAM 4.

Showing the *new* plot of land used for the soil inoculations (Part II.). The soil was inoculated with six gallons of sewage on the following dates:—September 25th, 27th, 30th; October 1st, 2nd, 3rd, 4th, 5th, 6th, 8th, 10th, 11th, 13th, 14th, 15th, 17th (A^1 collected afterwards), 18th, 19th, 21st, 22nd (A^2 collected), 26th, 27th, 28th (A^3 collected). Total amount, 138 gallons. A^4, A^5, A^6, A^7, A^8, A^9, A^{10}, A^{11}, A^{12} collected November 5th, 12th, 26th; December 17th, 1901; January 2nd, 27th; February 24th; March 19th; April 8th, 1902, respectively, 8, 15, 29, 50, 66, 91, 119, 132, 162 days after last inoculation.



Wooden frame 4′×3′ (internal dimensions) and 8″ deep, 2″ above surface and 6″ below level of surrounding soil.
Divided with stout string into 12 equal divisions of 1 ft. each.

Thanet sand, artificially laid down (4×3′ and 6″ deep) on September 24th, 1901.

Wooden frame 4′×3′ and 8″ deep. Sunk in dug out space and subsequently filled with Thanet sand.

A sample of the soil examined bacteriologically previous to the sewage inoculation process yielded the following results :—

Total NUMBER of bacteria.—1,700 per gramme.

B. COLI (and allied forms).—None could be found in 1 gramme.

B. ENTERITIDIS SPOROGENES.—Negative result with 1 gramme.

"*GAS*" *in gelatine* "*shake*" *cultures.*—Negative result 0·1 gramme (third day at 20° C.).

STREPTOCOCCI—None in 0·1 gramme.

From the above it will be seen that the experiments were commenced with a soil of great bacterial purity.

The plot was watered equally all over with 6 gallons of cesspool sewage on the following dates :—

September 25th, 1901.
September 27th, 1901.
September 30th, 1901.
October 1st, 1901.
October 2nd, 1901.
October 3rd, 1901.
October 4th, 1901.
October 5th, 1901.
October 6th, 1901.
October 8th, 1901.
October 10th, 1901.
October 11th, 1901.
October 13th, 1901.
October 14th, 1901.
October 15th, 1901.
October 17th, 1901 (A^1 collected immediately afterwards).
October 18th, 1901.
October 19th, 1901.
October 21st, 1901.
October 22nd, 1901 (A^2 collected immediately afterwards).
October 26th, 1901.
October 27th, 1901.
October 28th, 1901 (A^3 collected immediately afterwards).

Total amount applied = 138 gallons.

The remaining samples of soil were collected on the following dates :—

Soil A^4, November 5th, 1901 (8th day)		
" A^5, November 12th, 1901 (15th day)		
" A^6, November 26th, 1901 (29th day)		
" A^7, December 17th, 1901 (50th day)		
" A^8, January 2nd, 1902 (66th day)	Subsequent to the last inoculation process.	
" A^9, January 27th, 1902 (91st day)		
" A^{10}, February 24th, 1902 (119th day)		
" A^{11}, March 19th, 1902 (132nd day)		
" A^{12}, April 8th, 1902 (162nd day)		

The following is an account of the results of the bacteriological examination of the various samples of soil under :—

1. Total number of bacteria.
2. Gas-forming bacteria.
3. Spores of B. enteritidis sporogenes.
4. B. coli.
5. Streptococci.
6. General summary.

1. *TOTAL NUMBER of bacteria.*—The results obtained are shown in the following table :—

TABLE 3.

Showing as regards the TOTAL NUMBER of BACTERIA the results of the Bacteriological Examination of Soils A^1 to A^{12}.

[Part 2. New Plot.]

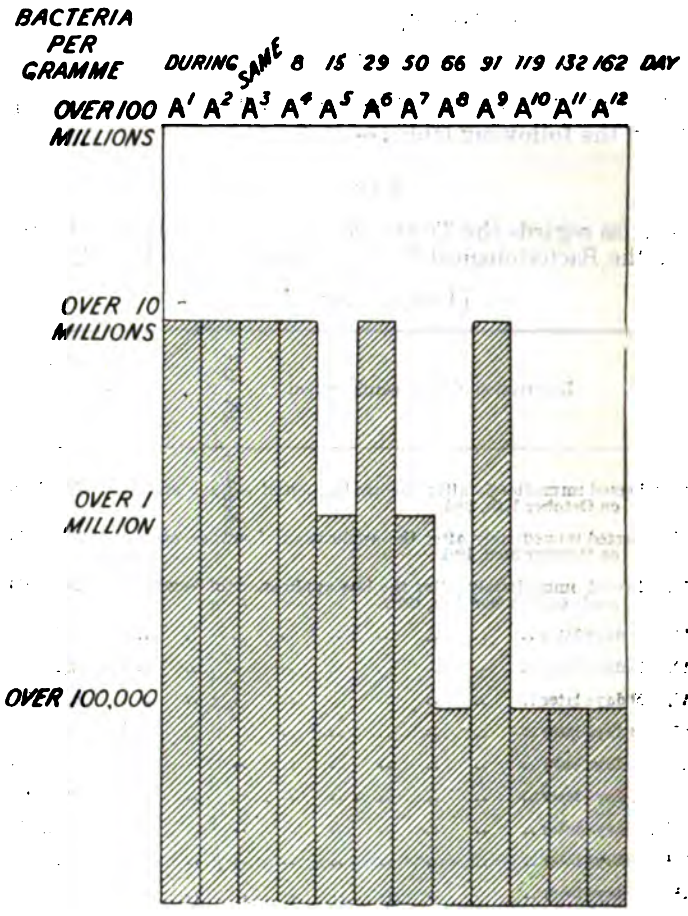
Description of the Sample of Soil.	Total Number of Bacteria in 1 gramme (gelatine at 20° C.).
Soil A^1, collected immediately after the application of sewage made on October 17th, 1901.	23,300,000
" A^2, collected immediately after the application of sewage made on October 22nd, 1901.	17,000,000
" A^3, collected immediately after the last application of sewage made on October 28th, 1901.	23,200,000
" A^4, 5 days later	26,600,000
" A^5, 15 days later	2,200,000
" A^6, 29 days later	12,240,000
" A^7, 50 days later	3,300,000
" A^8, 66 days later	340,000
" A^9, 91 days later	12,200,000
" A^{10}, 119 days later	820,000
" A^{11}, 132 days later	430,000
" A^{12}, 162 days later	360,000

It will be seen from the table that soil A^1 collected immediately after the application of sewage made on October 17th, 1901, *i.e.*, after the application to the plot of 96 gallons of sewage contained more than 23 million bacteria per gramme. It will be remembered that the soil, prior to inoculation, contained only 1,700 microbes in 1 gramme. Soils A^2 and A^3 collected, the former after a total application of 120 gallons, and the latter after 138 gallons in all had been applied to the soil, contained 17 and 23 million bacteria respectively in 1 gramme. At this point the further application of sewage was discontinued, yet soil A^4 collected

DIAGRAM 5.

Showing as regards total number of bacteria the results of the bacteriological examination of Soils A[1] to A[12].

[Part 2. New plot.]



8 days later contained over 26 million microbes, so that to start with a sustained multiplication of the bacteria seems to have occurred in the soil. From this time onwards the decline in the number of bacteria was marked, although not uniform in character, and, as in last year's experience, there seemed to be periods distinguished by an apparent recrudescence of vitality among the sewage microbes (Soils A^6 and A^9). Soils A^{10}, A^{11} and A^{12}, collected 119, 132 and 162 days subsequent to the last inoculation contained about 800,000, 400,000, and 300,000 microbes respectively per gramme. Soil A^{12} then contained about $\frac{1}{74}$ the number of microbes found in soil A^4, but over 200 times as many as the soil in its virgin state. So that although the sewage bacteria declined in number in the soil as time went on, the number still remaining, even after 162 days, were far in excess of the original bacterial contents of the soil.

2. "*GAS*" *in gelatine* "*shake*" *cultures* (24 hours at 20° C.). The results obtained by the use of this test are shown in Table 4 and Diagram 6.

TABLE 4.

Showing as regards "GAS" in gelatine "shake" cultures (24 hours at 20° C.), the results of the Bacteriological Examination of Soils A^1 to A^{12}.

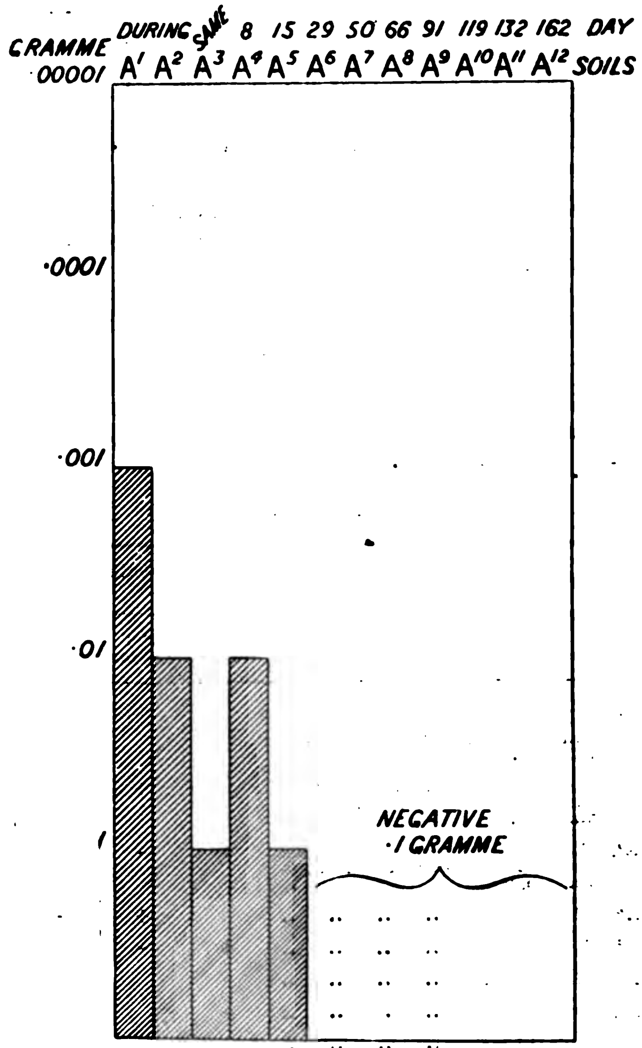
[Part 2. New Plot.]

Description of the Sample of Soil.	"Gas" in Gelatine "Shake" Cultures (24 hours at 20° C.) inoculated with—			
	0·1 gramme.	0·01 gramme.	0·001 gramme.	0·0001 gramme.
Sample A^1, collected immediately after the application of sewage made on October 17th, 1901.			+	-
" A^2, collected immediately after the application of sewage made on October 22nd, 1901.		+	-	
" A^3, collected immediately after the last application of sewage made on October 28th, 1901.	+	-		
" A^4, 8 days later		+	-	
" A^5, 15 days later	+	-		
" A^6, 29 days later	-			
" A^7, 50 days later	-			
" A^8, 66 days later	-			
" A^9, 91 days later	-			
" A^{10}, 119 days later	-			
" A^{11}, 132 days later	-			
" A^{12}, 162 days later	-			

DIAGRAM 6.

Showing as regards "gas" in gelatine "shake" cultures the results of the bacteriological examination of Soils A[1] to A[12].

[Part 2. New plot.]



It will be noted that Soil A^1, collected during the inoculation process, gave a positive result with $\frac{1}{1000}$ gramme. The soil, prior to inoculation, it will be remembered gave a negative result with $\frac{1}{10}$ gramme. Soils A^2 and A^3 contained fewer, particularly the latter, gas-forming bacteria. But Soil A^4 collected 8 days after the last inoculation gave a positive result with $\frac{1}{100}$ gramme. Soil A^5 (15 days) yielded a negative result with $\frac{1}{100}$, but a positive one with $\frac{1}{10}$ gramme. All the remaining Soils A^6 to A^{12} gave a negative result with $\frac{1}{10}$ gramme, so that it may safely be concluded that an ultimate decline in the number of gas-forming bacteria in the soil took place subsequent to a cessation of the sewage inoculation process.

3. *SPORES OF B. ENTERITIDIS SPOROGENES* (Klein's "enteritidis change" in anaërobic milk culture).—The results obtained by the use of this test are shown in Table 5.

Table 5.

Showing as regards the number of Spores of B. Enteritidis Sporogenes (Klein's "enteritidis change" in anaërobic milk cultures), the results of the Bacteriological Examination of Soils A^1 to A^{12}.

[Part 2. New Plot.]

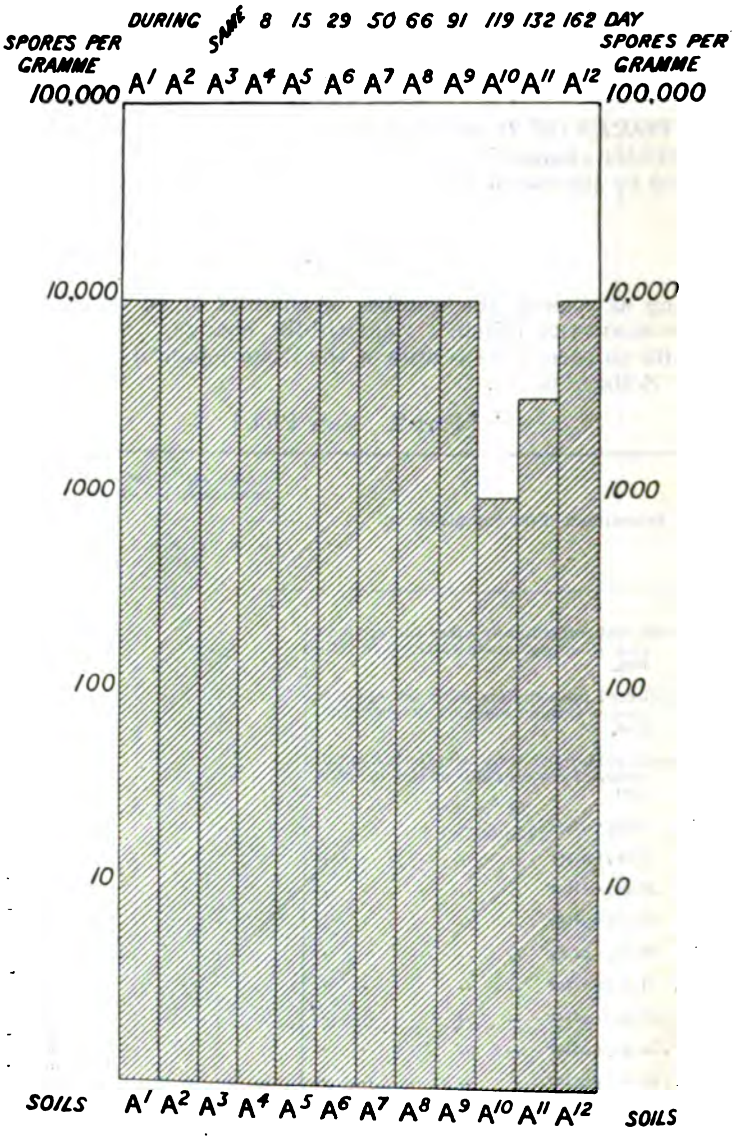
Description of the Sample of Soil.	Number of Spores of B. enteritidis Sporogenes per gramme of Soil.			
	At least 100.	At least 1,000.	At least 10,000.	At least 100,000.
Soil A , collected immediately after the application of sewage made on October 17th, 1901.			+	-
„ A^2, collected immediately after the application of sewage made on October 22nd, 1901.			+	-
„ A^3, collected immediately after the last application of sewage made on October 28th, 1901.			+	-
„ A^4 8 days after			+	-
„ A^5, 15 days after			+	-
„ A^6, 29 days after			+	-
„ A^7, 50 days after			+	-
„ A^8, 66 days after			+	-
„ A , 91 days after			+	-
„ A^1 , 119 days after		+	-	
„ A^{11}, 132 days after		+	?+	-
„ A^{12}, 162 days after			+	-

In considering this table, it should be borne in mind that 1 gramme of the soil antecedent to its inoculation with sewage

DIAGRAM 7.

Showing as regards B. enteritidis sporogenes the result of the bacteriological examination of Soils A^1 to A^{12}.

[New Plot. Part 2.]



contained no spores of this anaërobe. Yet soils A^1, A^2, A^3 collected after 96, 120, and 138 gallons of sewage had been intermittently applied to the soil, contained each at least 10,000, but less than 100,000 spores of B. enteritidis sporogenes per gramme respectively. Soils A^4, A^5, A^6, A^7, A^8 and A^9, collected respectively 8, 15, 29, 50, 66 and 91 days later, all contained the same high number of spores of this anaërobe. Soils A^{10} and A^{11} (119th and 132nd day) were not quite so conspicuous in this respect; but A^{12} collected on the 162 day subsequent to the last inoculation process contained the same number of spores as the samples collected during the inoculations. Broadly speaking then, it may be said that unlike the gas-forming bacteria, the number of spores of B. enteritidis sporogenes remained nearly constant throughout the course of the investigation.

APP. B, No. 6.

On the Inoculation of Soil with Sewage by Dr. Houston.

4. *B. COLI* (*and allied forms*).—The results obtained in this part of the investigation are shown in Table 6 and Diagram 8.

TABLE 6.

Showing as regards B. coli (and allied forms) the results of the Bacterial Examination of Soils A^1 to A^{12}, Part 2, New plot.

[Previous to inoculation the soil contained no B. coli in 1 gramme.]

Sample of soil.	Amount of soil.	Number of microbe.	"Gas" in gelatine "shake" cultures at 20° C [unless otherwise stated none of the microbes liquefied gelatine within 30 days].	Indol in broth culture (5 days at 37° C.).	Acidity in litmus milk cultures (5 days at 37° C.).	Acid clot in litmus milk cultures (5 days at 37° C.).	Greenish-yellow fluorescence in neutral red broth cultures (5 days at 37° C.).	Marks allotted (of illustrative value only.)*	Number of days subsequent to last inoculation.
	Gramme.								
A^1	·001	1	+	-	+	+	+	4,000	Collected during the inoculation process.
"	·0001	2	+	-	+	+	+	40,000	
"	·00001	3	+	-	+	+	+	400,000	
A^2	·0001	4	+	-	+	+	+	40,000	" "
"	·00001	5	+	+	+	+	+	500,000	
A^3	·0001	6	+	+	+	+	+	50,000	Same day.
"	·00001	7	+	+	+	+	+	500,000	
A^4	·0001	8	+	+	+	+	+	50,000	8
"	·00001	9	+	+	+	+	+	500,000	

* The marks are allotted on the same principle as in Table 2, Part 1. (*See* footnote Table 2, Part 1.)

TABLE 6.—*continued.*

Sample of soil.	Amount of soil.	Number of microbe.	"Gas" in gelatine "shake" cultures at 20° C. [unless otherwise stated none of the microbes liquefied gelatine within 30 days].	Indol in broth culture (5 days at 37° C.).	Acidity in litmus milk cultures (5 days at 37° C.).	Acid clot in litmus milk cultures (5 days at 37° C.).	Greenish-yellow fluorescence in neutral red broth cultures (5 days at 37° C.).	Marks allotted (of illustrative value only).*	Number of days subsequent to last inoculation.
	Gramme.								
A^5	·0001	10	+	+	+	+	+	50,000	15
"	·00001	11	+	+	+	+	+	500,000	
A^6	·01	12	+	+	+	+	+	500	29
"	·001	13	+	-	+	-	-	2,000	
A^7	·01	14	+	+	+	+	+	500	50
"	·001	15	+	+	+	+	+	5,000	
"	·0001	16	+	+	+	+	+	50,000	
A^8	·01	17	-	As no "gas" not studied further.				0	66
"	·001	18	-	"	"	"	"	0	
"	·0001	19	-	"	"	"	"	0	
A^9	·01	20	+	+	+	-	+	400	91
A^{10}	·01	21	+	-	+	-	-	200	119
"	·001	22	+	-	+	-	? + doubtful.	2,500	
A^{11}	·01	23	+ feeble.	-	+ feeble.	-	-	100	132
A^{12}	·01	24	-	As no "gas" not studied further.				0	162
"	·001	25	+ feeble.	-	+ feeble.	-	-	1,000	
"	·0001	26	+ feeble.	-	+ feeble.	-	-	10,000	

* The marks are allotted on the same principle as in Table 2, Part 1. (*See* footnote Table 2, Part 1.)

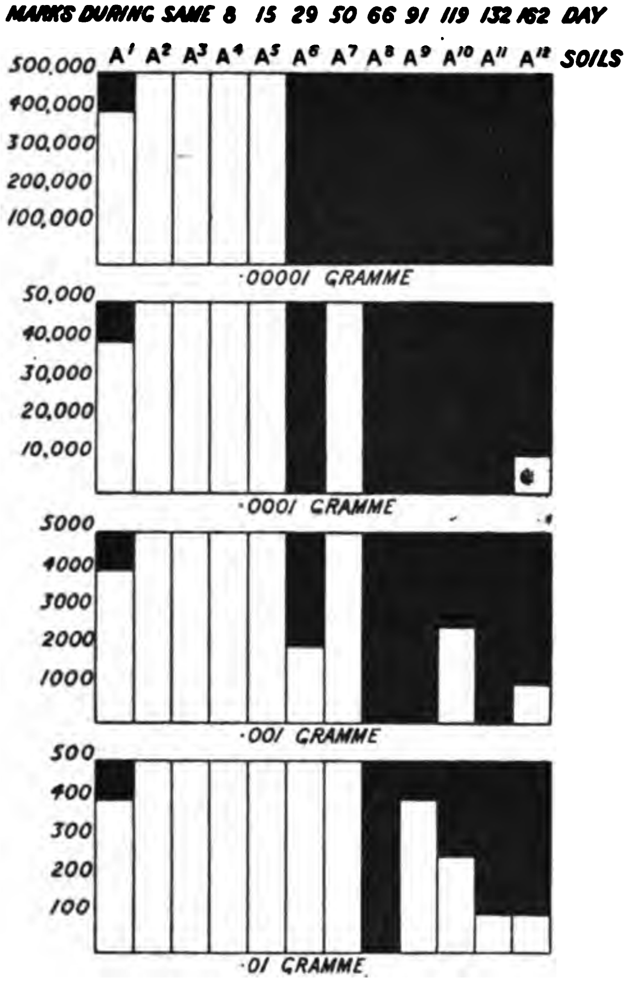
Preliminary to an analysis of the results shown in Table 6, it needs to be borne in mind that the soil previous to inoculation contained no coli-like microbes in 1 gramme.

Soil A^1, collected after "treating" the plot with 96 gallons of sewage, contained at least 100,000 coli-like microbes which gave positive response to all the tests employed, the indol test alone

DIAGRAM 8.

Showing the decline in the number of B. coli in the soil subsequent to the last inoculation with cesspool sewage.

[Part 2. New plot.]



When a coli-like microbe was present in a higher dilution (or possessed more positive characters in the higher dilution than in the lower dilution), then the lower dilution is credited with also possessing microbes of similar character.

[The black portion represents the decline in the number of B. coli. The white columns show the marks allotted to the various samples of soil as regards their B. coli contents.]

excepted. Soils A^2 and A^3, collected after the intermittent application to the soil of 120 and 138 gallons of sewage respectively, yielded B. coli—typical in all respects in $\frac{1}{100,000}$ gramme. Similarly soils A^4 and A^5 (collected 8 and 15 days subsequent to the last inoculation process) contained in the same amount of soil microbes completely characteristic of B. coli. From this point to the close of the investigations, no coli-like microbes could be found in ·00001 gramme of the soil.

Passing next to the ·0001 gramme cultures, it is found that although soil A^6 (29 days) yielded negative results, the next sample A^7 (50 days) contained B. coli of typical sort.

From this point onward until the close of the enquiry it might have been alleged that B. coli had altogether disappeared from this amount of soil were it not for the fact that in the last soil (A^{12}, 162 days) was found a microbe which could not with justice be passed over without consideration, since it possessed positive characters, though of a feeble kind.

As regards the ·001 gramme cultures, but little need be added to what has been already said except that in the case of soil A^6 (29 days) a gap was partially filled by the presence of a coli-like microbe which claimed two out of a total of five marks. Further, soil A^{10} (119 days) claimed attention owing to the isolation of a suspected B. coli, which on subculture was awarded 2·5 marks.

Dealing next with the lowest dilution (·01 gramme), completely positive B. coli was encountered up to the 50th day (A^7). A complete break occurred in the case of soil A^8 (66th day). But soil A^9 (91st day) contained a microbe answering to four out of five positive tests. A^{10} (119th day) yielded a coli-like microbe which claimed two marks, and in virtue of a slightly more typical strain isolated from a higher dilution 2·5 marks. A^{11} (132nd day) contained a microbe to which one mark was assigned, it possessed certain positive attributes, but responded to them in the feeblest manner. As regards A^{12} (162nd day) although seemingly it contained no coli-like microbes in this dilution (·01 gramme), nevertheless, in the higher dilutions, microbes were isolated showing some faint resemblance to B. coli.

The results, as a whole, seem conclusively to indicate that a virgin sandy soil "heavily" polluted with excremental matters can in process of time "purify itself" so far as typical B. coli is concerned. But it is also evident that the less typical strains of B. coli can persist, although in reduced numbers, for a period covered by weeks and even months. So that all that it can be safely concluded from these experiments is the relative disappearance of B. coli from the soil of experiment. It is to be regretted that there is no information to show whether the B. coli of feeble characters, isolated towards the end of the investigation, were the descendants of a stock yielding at the outset positive response to all the tests applied; or whether such atypical B. coli were merely microbes which had been overlooked in the earlier cultures owing to the presence in the soil in greater abundance of the more typical races of B. coli. Tentatively, there is a temptation to advance the

hypothesis that B. coli, typical in all respects, may under certain conditions gradually lose some of its positive attributes or retain them only in diminished degree. But this problem must for solution wait pending further investigations.

5. *STREPTOCOCCI.*—The results as regards streptococci may be briefly described as follows :—

SOIL A[1].—(obtained after 96 gallons had been intermittently applied to the soil).—Streptococci 1 and 2 isolated from ·0001 gramme (surface agar plate culture at 37° C.) of the soil.

SOIL A[2].—(obtained after 120 gallons had been intermittently applied to the soil).—The number of minute colonies in the plates was very great, but unfortunately those sub-cultured either showed no growth or a growth of bacilli. Although the result was negative it is almost certain that streptococci were in reality present.

SOIL A[3].—(obtained after 138 gallons had been intermittently applied to the soil).—Streptococci 3, 4, 5, isolated from ·0001 gramme and streptococci 6 and 7 from ·001 gramme (surface agar cultures at 37° C.) of the soil.

SOIL A[4].—Streptococci 10 and 11 isolated from ·001 gramme (surface agar cultures at 37° C.) of the soil.

SOIL A[5].—No streptococci could be found in ·001 gramme (surface agar plate cultures at 37° C.) of the soil. The subculture of 16 of the minute colonies occurring in the plate cultures yielded negative results as regards streptococci.

SOIL A[6].—No streptococci could be found in ·001 gramme (surface agar plate cultures at 37° C.) of the soil. The sub-culture of 10 of the minute colonies occurring in the plate cultures yielded negative results as regards streptococci.

SOIL A[7].—(? Streptococcus 16) isolated from ·001 gramme (agar plate cultures at 37° C.). Nine subcultures were made in addition of minute colonies occurring in the plate cultures and suspected of being streptococci, but the result was in each case negative.

SOIL A[8].—(? Streptococci 17, 18, 19, 20, 21) isolated from ·001 gramme (agar plate cultures at 37° C.). Five sub-cultures were made in addition of minute colonies occurring in the plate cultures and suspected of being streptococci, but the result was negative in each case.

SOIL A[9].—(? Streptococci 22, 23, 24, 25) isolated from ·001 gramme (agar plate cultures at 37° C.). Six

sub-cultures were made in addition of minute colonies occurring in the plate cultures and suspected of being streptococci, but the result was negative in each case.

SOIL A[10].—No streptococci could be found in ·001 gramme (agar plate cultures at 37° C.). Ten sub-cultures of the minute colonies occurring in the plate cultures were made, but the result was uniformly negative.

SOIL A[11].—(? Streptococcus 26) isolated from ·001 gramme (agar plate culture at 37° C.) of the soil.

SOIL A[12].—(? Streptococci 27, 28, 29, 30) isolated from ·001 gramme (agar plate cultures at 37° C.) of the soil. Six subcultures were made in addition of minute colonies occurring in the plate cultures and suspected of being streptococci, but the result was negative.

The following is a brief account of the chief morphological and biological characters of the streptococci (or microbes suspected of being streptococci) isolated from the various samples of soil:—

Streptococci 1 and 2 isolated from ·0001 gramme (agar plate cultures at 37° C.) of soil A[1], were not specially studied beyond the point of coming to the conclusion that the colonies really were those of streptococci. The former (1) formed short chains, the latter (2) chains of great length. In broth cultures, streptococcus 1 produced uniform turbidity, and streptococcus 2 left the liquid quite clear and transparent, the whole of the growth occurring as fluffy white masses lying at the foot of the tube.

Streptococcus 3 isolated from ·0001 gramme (agar plate cultures at 37° C.) of soil A[2].

Morphology.—An undoubted streptococcus, forming chains of great length.

Gelatine "streak" cultures (at 20° C.).—The colonies were very minute and transparent looking. No liquefaction occurred.

Broth cultures (37° C.).—The broth remained quite transparent, at the foot of the tube there was a white somewhat flocculent and granular deposit.

Litmus milk cultures (37° C.).—Strong acid and solid clot within two days.

Streptococci 4, 5, and 6 were so alike that they may be considered together. They were isolated from ·0001 (4 and 5) and ·001 (6) gramme (agar plate cultures at 37° C.) of sort A[2].

Morphology.—Unquestionably streptococci forming chains of medium length.

Gelatine "streak" cultures (20° C.).—The colonies were very minute and transparent looking. No liquefaction occurred.

Broth cultures (37° C.).—Mixtures of diffuse and granular cloudiness with cirrhus-like growths floating throughout the liquid.

Litmus milk cultures (37° C.).—Little or no visible change in three days.

Streptococcus 7 isolated from ·001 gramme (agar plate cultures at 37° C.) of soil A[3].

Morphology.—A long chained streptococcus belonging to the class in which the elements composing the chains look as if they had been longitudinally compressed (along the line of the chain), instead of presenting a "drawn-out" appearance.

Gelatine streak cultures (20° C.).—The colonies were minute and transparent looking. No liquefaction occurred.

Broth cultures (37° C.).—The broth remained nearly quite transparent. At the foot of the tube a white *cumulus-like* growth collected.

Litmus milk cultures (37° C.). Acidity, but no clot.

Streptococci 10 and 11 isolated from ·001 gramme (agar plate cultures at 37° C.) of soil A[4] were not specially studied beyond arriving at the conclusion that they really were streptococci. Both formed chains of medium length, but the former in broth cultures left the medium almost clear, except for *cirrhus-like* growths which clung to the sides and foot of the tube; whereas the latter gave rise to an appearance of diffuse cloudiness.

[? *Streptococcus* 16] isolated from ·001 gramme (agar plate cultures at 37° C.) of soil A[7].

Morphology.—Fairly long chains of large and most irregularly shaped cocci (?) which stained well by Gram's method.

Gelatine (20° C.) *and agar* (37° C.) *streak cultures.*—Growth perhaps rather more confluent, rapid, and opaque in character than is usually the case with streptococci. No liquefaction occurred.

Broth cultures (37° C.).—Broth quite clear, with, at the foot of the tube a white woolly mass.

Litmus milk cultures (37° C.).—Acidity but no clot.

Remarks.—Could not be eliminated from the streptococcus group although possessed of somewhat peculiar characters.

[? *Streptococci* 17, 18, 19, 20, 21] were so alike that may be considered together. They were isolated from ·001 gramme (agar plate cultures at 37° C.) of soil A[8].

Morphology.—Cocci (?) in masses and as short chains, very irregular in shape and size and having a granular appearance in the unstained condition; they stained well by Gram's method.

Gelatine (20° C.) *and agar* (37° C.) "*streak*" *cultures.*—Growth rather more rapid opaque and luxuriant than is usually the case with streptococci.

Broth cultures (37° C.).—Almost transparent; at the foot and sides of the tube a white viscous growth was to be seen.

Litmus milk cultures (37° C.).—Acidity but no clot.

Remarks.—Could not, with certainty, be dissociated from the streptococcus group although obviously different from the streptococci isolated from the earlier samples of soil.

[? *Streptococci* 22, 23, 24, 25]; [? *Streptococcus* 26]; and [? *Streptococci* 27, 28, 29, 30] were isolated from ·001 gramme (surface agar plate cultures at 37° C.) respectively of soils A[9], A[11] and A[12]. They all seem to be possessed of somewhat similar but peculiar characters and could not with certainty be differentiated from the streptococci above described (17, 18, 19, 20, 21).

It may be worthy of note that streptococcus 3 (Soil A[3]) produced strong acid and clotted milk within two days. The streptococci subsequently isolated did not clot milk.

The proper interpretation to be placed on these results is, I think, that the streptococci of normal type did not persist for long in the soil, but that certain streptococci, or pseudo-streptococci, retained their vitality to the end of the investigation. Of course, it must be remembered that the conditions in Part 2 were widely different from those in Part 1, since in Part 1 garden soil rich in "soil microbes," and in Part 2 virgin soil respectively, were being dealt with. In the case of the old plot the sewage microbes had to compete with an enormous number of saprophytic bacteria firmly established there by a process of natural selection, whereas in the case of the new plot the sewage microbes had only their own brethren to contend with. So that it might, I think, have been anticipated that the sewage microbes would be apt to retain their vitality for a longer period in the new than in the old plot.

APP. B, No. 6.

On the Inoculation of Soil with Sewage; by Dr. Houston.

SUMMARY OF PART II.

6. The following is a *general summary* of the results obtained in Part 2 of the inquiry :—

Total number of bacteria.—The addition of 138 gallons of cesspool sewage intermittently to the soil increased its total bacterial contents from 1,700 to over 20 millions microbes per gramme. Although the bacteria gradually (but not uniformly) decreased in number during the course of the investigation—162 days after the last inoculation—the soil still contained over 200 times as many microbes as in its virgin state. Nevertheless the reduction from 26,600,000 (maximum number) observed in soil A^4 (8 days after the last inoculation) to 360,000 found in soil A^{12} (162 days after the last inoculation) is striking.

Gas-forming bacteria.—The decline in the number of gas-forming bacteria was well marked. Thus, as compared with soil A^4 the reduction in A^5 was ten-fold, and in soils A^6 to A^{12} at least one-hundred-fold.

Spores of B. enteritidis sporogenes.—The addition of the 138 gallons of sewage raised the number of spores from none in 1 gramme to at least 10,000, but less than 100,000 per gramme. On the 8th, 15th, 29th, 50th, 66th and 91st day after the last inoculation, the numbers remained the same. And although the numbers decreased somewhat in soils A^{10} and A^{11}, the last soil (A^{12}) collected 162 days after the last inoculation contained the same high numbers as the earlier samples. So that it may, I think, fairly be said that the number of spores of B. enteritidis sporogenes remained nearly constant throughout the period of investigation.

B. coli (and allied forms).—Starting with a soil containing no B. coli in 1 gramme, the intermittent addition to it of 138 gallons of sewage altered so greatly its bacterial composition, that B. coli, typical in all respects, was isolated from $\frac{1}{100,000}$ gramme (soils A^2, A^3, A^4, A^5). From this point onwards the decline in the number of B. coli of all sorts, but more particularly those of completely typical sort was well marked. From this it may perhaps be inferred that even in the comparative absence of competing microbes of saprophytic sort B. coli cannot maintain its existence for an indefinite period in the surface layers of soil.

Streptococci.—Although the *relative* death of microbes *unquestionably* belonging to the streptococcus group was, beyond doubt, the complete disappearance of certain streptococci or pseudo-streptococci, was by no means established. It may be suggested that the comparative absence of competing "soil microbes"

may have materially influenced the results. However this may be, it should again be noted that I have never contended that *all races* of streptococci are of feeble vitality, and readily perish under saprophytic conditions. Nevertheless, it is a difficult matter in practice to sift the delicate and therefore significant (in the sense of my investigations) streptococci from their more hardy allies. And it is still more difficult (often impossible) to state in definite words the reasons for considering some streptococci less significant than others, because one is frequently dealing with personal impressions rather than with facts capable of being demonstrated.

Through the kindness of Mr. F. Campbell Bayard, I am enabled to give a table of meteorological observations covering the whole period of the investigation, which was carried out within half a mile of the plot of land used for the above experiments. The table will be found at the end of this report. But this year, as last year, I hesitate to draw any inferences from these meteorological data in connection with my work. Although it is known that sunshine, extreme dryness, and severe cold may act injuriously on bacterial life ; and that, conversely, warmth, a moderate degree of moisture and shade may be favourable to the vitality of micro-organisms ; these conditions (individually or collectively) cannot accurately be weighed in relation to the life history of bacteria naturally existing in the soil, or artificially added thereto.

But I have marked on the table the dates on which the various samples of soil were collected, and the maximum and minimum observations for each month.

Conclusions.

B. General summary and inferences as regards soil investigations carried out during 1900–1901 *and* 1901–1902.

As the result of two years' work on this subject the following conclusions and inferences may, I think, safely be drawn.*

1. The addition of sewage to an ordinary garden soil *does not* seemingly lead to a *marked nor indeed to other than temporary increase of the sewage microbes in general at the expense of the soil bacteria.* On the contrary, the hardier soil bacteria seem gradually to oust the more delicate sewage microbes in the struggle for existence (Series 1 and 2 of Part I., 1900–1901).

But the addition of sewage to a *virgin sandy soil* leads to an *enormous increase in the total number of microbes* as compared with the number present in the soil antecedent to the inoculation

* It must, however, be understood that I limit my conclusions to the *surface* layers of soil and the soils of experiment.

process. And although *the numbers* rapidly but not uniformly *diminish*, the soil *does not* within a period of *some months revert to its original state* (Part II., 1901–1902).

2. The addition of sewage to a garden soil tends primarily to *increase the ratio of total number of bacteria to spores of aerobic bacteria*, but this alteration is apt to be soon lost (Series 1 (to some extent), Series 2 (to a greater extent), Part I., 1900–1901).

3. The addition of sewage to a soil leads to an increase in the number of *indol-producing* bacteria. This increase, however, tends to soon disappear or only to be maintained in a diminished degree. Periods of seeming recrudescence of vitality of these indol-producing bacteria would seem to be indicated (Series 3, Part I., and Series A, Part II., 1900–1901).

4. The addition of sewage to a soil leads to an increase in the number of *gas-forming bacteria*. But sometimes rapidly, sometimes more slowly, this increase wholly or in great measure disappears. Occasionally a seeming recrudescence of vitality of the gas-forming bacteria takes place (Series 1, 2, 3, Part I., and Series A, Part II., 1900–1901, and Part II., 1901–1902).

5. The addition of sewage to a soil leads to an increase in the number of *spores of B. enteritidis sporogenes*. The experiments sometimes seemed to indicate a partial disappearance of the spores of this anaerobe from the soil during the period of observation, but taking the results as a whole it may be said that any diminution in the number of spores of B. enteritidis sporogenes that may have taken place compared with the marked reduction in the abundance of other *but non-sporing* microbes of excremental sort, *e.g.*, B. coli and streptococci was small in amount (Series 1, 2, 3, Part I., and Series A, Part II., 1900–1901, and Part I. and II., 1901–1902).

6. The addition of sewage to a soil greatly alters its bacterial composition in respect of *B. coli and allied forms*. But this alteration tends to become less apparent as time gradually elapses. Sometimes the relative disappearance of B. coli is rapid, sometimes much slower, and periods of a *seeming* return to vitality are not uncommon. Moreover, the total disappearance of microbes *seemingly akin* to B. coli was by no means always established, when the period of scrutiny was extended over weeks and even months. But there can be little doubt that the experiments as a whole tend to confirm my previous inferences, namely, that if B. coli does not perish in the surface layers of soil, it certainly becomes greatly reduced in numbers; so that its presence in a soil in any number may be taken as affording reasonable grounds for suspecting pollution of *comparatively recent* sort. The relative death of the completely typical races of B. coli was much more apparent than that of the less typical forms. But this may in reality mean that the originally completely typical strains of B. coli lose some of their positive attributes during their prolonged sojourn in the soil (Series 1, 2, 3, Part I., and Series A, Part II., 1900–1901, and Parts I. and II., 1901–1902).

7. The addition of sewage to a soil may be detected by the presence of *streptococci* even in a minimal amount of the soil thus polluted. But the disappearance (relatively if not actually) of the microbes *unquestionably* to be regarded as *streptococci* seems to be extremely rapid. Nevertheless, the persistence of certain kinds of streptococci or of pseudo-streptococci for long periods in the soil was observed on more than one occasion. The differentiation of these streptococci seemingly of peculiar type from other streptococci of greater significance (because their presence points, it is believed, to contamination with matters of extremely recent animal outcome) is a matter of great difficulty and involves the personal equation. I am unable at present to express a definite opinion regarding the points (morphological or biological) on which reliance should be placed in effecting a discrimination of the above kind. But the experiments as a whole tended to confirm the views I have previously expressed, namely, that the presence of streptococci (particularly those *indubitably* to be regarded as true streptococci) in any number in a soil points to extremely *recent* contamination (Series 1, 2, 3, Part I., and Series A, Part II., 1900-1901; and Parts I. and II., 1901-1902).

In conclusion, whatever interpretation be ultimately placed on these results, the experiments as a whole, in the light of our present imperfect knowledge, go far to dispel the supposition so widely and firmly held that the surface layers of soil are a fertile breeding ground for microbes of pathogenic sort. On the contrary, the results are reassuring, inasmuch as they seem clearly to show that some kinds of soil "heavily" polluted with excremental matters tends soon to "purify itself" so far as the non-sporing microbes of intestinal sort (*e.g.*, B. coli and streptococci) are concerned. Nevertheless, extreme caution must be exercised in distinguishing between the surface and deeper layers of soil and between the *relative* and *actual* death of bacteria. From the point of view of the epidemiologist and in relation to enteric fever and cholera the marked decline in the number (relative death) of, at all events, typical B. coli subsequent to a cessation of the inoculation of the soil with sewage is of considerable importance. For if B. coli is rightly to be regarded as a more hardy germ than either B. typhosus or Koch's vibrio, it may inferentially be concluded that these pathogenic microbes would not be likely to maintain their vitality in the *surface* layers of soil for more than a brief period.

AP P. B, No. 6.

On the Inoculation of Soil with Sewage: by Dr. Houston

C.—METEOROLOGICAL OBSERVATIONS made at Cotswold, Maldon Road, Wallington, Surrey. Time 9 a.m. Height above Sea level, 140 ft.

Day of Month.	August, 1901.			September, 1901.			October, 1901.			November, 1901.			December, 1901.		
	Shade Max.	Shade Min.	Rain depth.	Shade Max.	Shade Min.	Rain depth.	Shade Max.	Shade Min.	Rain depth.	Shade Max.	Shade Min.	Rain depth.	Shade Max.	Shade Min.	Rain depth.
	°	°	In.	°	°	In.	°	°	In.	°	°	In.	°	°	In.
1	73·8	57·2	—	64·5	52·4	—	**73·2**	52·0	·52	50·8	43·3	—	49·4	41·0	—
2	74·7	54·5	—	61·1	41·4	—	64·9	57·3	·36	53·9	34·5	—	52·1	42·9	—
3	72·7	54·2	—	63·2	52·4	—	66·9	53·3	·08	44·3	26·4	—	46·9	42·0	—
4	70·4	55·3	—	63·1	52·0	—	56·1	50·3	·48	36·7	25·3	·02	**42·2**	31·8	—
5	67·3	51·2	·07	64·2	42·4	—	56·7	40·9	—	**36·7**	31·6	·01	44·0	34·8	·01
6	72·6	52·1	·03	65·7	41·8	—	60·7	45·2	·09	40·2	29·1	·01	53·6	35·1	—
7	76·7	51·3	·01	68·7	46·0	—	52·0	40·5	—	46·1	29·2	—	55·1	35·4	·09
8	76·9	61·2	—	74·1	55·9	·20	**59·1**	40·4	·02	51·1	35·5	—	54·7	51·5	·06
9	81·4	54·5	—	69·2	61·2	—	58·2	47·2	—	49·2	38·4	—	45·7	42·1	·21
10	78·1	59·3	—	69·9	54·6	—	58·9	37·1	—	51·9	44·2	—	41·9	32·5	·02
11	69·5	50·6	·18	[60·9]	50·0	·05	55·0	46·2	—	54·2	48·2	·01	43·1	33·4	·08
12	66·8	52·2	·01	**63·7**	51·5	—	61·8	49·5	—	**52·2**	4·85	·09	46·6	33·4	1·38
13	69·3	53·2	—	63·1	50·3	—	61·8	41·1	—	47·9	45·1	·21	43·2	37·6	·19
14	69·8	57·5	·22	66·0	50·2	—	57·7	41·0	—	40·9	35·3	—	40·4	40·3	·01
15	71·7	57·2	·04	63·0	50·2	—	**58·0**	36·2	·10	41·9	26·4	—	35·7	32·3	—
16	70·7	58·3	—	63·1	[37·4]	·69	59·3	46·2	·46	[27·8]	22·2	—	41·8	31·2	—
17	74·8	48·4	—	**66·3**	51·5	·09	**60·2**	49·5	·03	43·6	17·5	·01	**41·1**	25·4	·10
18	81·0	54·1	—	64·1	49·5	—	57·2	54·4	·66	50·3	24·4	—	**40·9**	26·2	—
19	77·9	52·9	—	63·7	46·6	—	59·6	43·5	·14	**51·9**	41·1	·02	42·7	29·4	—
20	70·8	54·3	—	66·3	53·4	39	57·2	34·4	—	53·3	49·3	—	33·1	21·5	·01
21	72·3	48·7	—	63·9	58·0	·02	54·3	33·5	·04	53·4	47·6	·04	[31·5]	24·4	—
22	73·6	47·0	—	67·2	53·4	—	**51·2**	39·9	·01	45·6	41·3	·13	36·1	25·6	—
23	77·1	46·2	—	64·9	58·1	—	53·6	37·2	·01	42·9	28·2	—	42·2	[21·3]	·36
24	76·7	45·9	—	66·3	55·1	—	53·7	35·2	·05	32·3	23·4	—	41·9	26·3	·75
25	81·4	50·3	·25	**68·9**	48·6	—	53·0	41·4	—	36·3	25·0	·03	40·8	32·6	·01
26	[61·1]	54·1	·08	67·2	50·2	—	[45·4]	30·8	—	**42·5**	26·2	·01	41·9	34·4	—
27	62·1	46·4	·82	66·1	43·0	—	56·7	26·2	—	42·7	34·9	—	40·2	32·5	·01
28	63·3	[45·2]	—	65·8	56·3	—	**59·7**	33·3	—	45·1	37·9	—	48·7	32·4	·56
29	65·9	49·2	—	72·6	48·3	—	**56·1**	51·2	0·6	43·1	29·6	—	53·2	39·4	·29
30	67·4	55·9	—	68·8	44·5	—	54·4	49·5	—	47·2	30·9	—	54·9	42·3	·02
31	67·8	56·1	·38				54·2	46·2	—				53·1	52·1	·09
Mean	72·1	52·6	2·08	65·9	50·1	1·44	57·6	42·9	3·11	45·2	34·0	0·59	44·4	34·4	4·5

NOTE.—The highest observation in each monthly column is underlined, and the lowest placed within brackets.

The records shown in thicker type correspond to the dates of collection of the various samples of soil.

C.—Meteorological Observations made at Cotswold, Maldon Road, Wallington, Surrey. Time 9 a.m. Height above Sea Level, 140 ft.—*continued.*

Day of Month.	January, 1902.			February, 1902.			March, 1902.			April, 1902.		
	Shade Max.	Shade Min.	Rain depth.	Shade Max.	Shade Min.	Rain depth.	Shade Max.	Shade Min.	Rain depth.	Shade Max.	Shade Min.	Rain depth.
	°	°	In.	°	°	In.	°	°	In.	°	°	In.
1	52·1	42·6	·11	38·0	32·3	—	53·0	36·3	—	54·3	47·5	—
2	**51·3**	45·1	—	34·3	30·9	·01	55·1	37·3	·03	49·3	32·3	—
3	53·3	40·4	—	34·7	30·8	·11	50·0	38·5	—	**53·3**	36·1	·02
4	52·6	4[illegible]·1	·17	**34·9**	32·0	—	45·8	37·2	—	52·7	35·2	·03
5	47·0	39·6	—	34·2	31·6	—	**48·3**	32·5	—	51·1	38·6	·06
6	51·0	37·9	—	38·6	32·0	·04	55·9	[27·2]	·01	47·3	37·4	—
7	45·7	39·4	—	36·8	32·5	—	50·7	27·3	·01	45·1	[28·7]	—
8	43·9	41·3	—	38·3	31·4	·07	51·2	40·0	—	**[43·6]**	37·1	—
9	50·6	39·5	·02	40·7	30·3	—	56·4	45·2	·09	46·9	34·3	—
10	51·9	43·5	—	32·8	26·5	—	50·0	44·2	—	46·9	36·9	—
11	49·8	48·4	·03	40·9	25·9	—	50·2	42·3	—	47·9	35·9	·10
12	48·4	40·5	—	[29·0]	21·5	—	52·1	40·3	—	51·9	40·1	—
13	38·4	35·4	—	35·8	16·2	—	56·2	34·8	—	57·9	35·5	—
14	**[34·4]**	29·1	—	32·0	18·4	·01	53·9	38·6	·68	54·9	32·2	·03
15	41·4	[22·5]	—	34·2	28·3	—	53·6	41·4	—	59·6	41·5	—
16	43·4	23·3	—	36·7	[13·3]	—	55·4	39·8	—	59·1	43·1	—
17	44·8	39·1	—	38·1	17·4	—	**59·1**	38·3	—	62·2	41·2	—
18	43·8	39·9	—	36·2	22·0	—	49·9	41·3	—	60·9	38·0	—
19	45·7	24·9	—	35·3	32·0	·01	**56·5**	43·3	—	66·2	40·5	·09
20	50·0	31·4	—	35·8	32·5	—	49·8	41·3	·11	61·0	45·5	·01
21	51·5	45·3	—	49·2	32·3	—	48·8	37·7	·16	60·0	4[illegible]·5	·10
22	51·0	46·1	·02	49·1	33·3	·07	47·9	37·0	·01	56·4	52·1	·18
23	48·4	41·9	—	49·3	38·2	·01	50·9	34·4	—	58·1	43·3	—
24	46·9	41·0	·13	**45·7**	44·2	·20	**[45·6]**	33·2	·29	63·8	40·2	—
25	40·1	30·4	—	46·7	41·7	·05	50·1	39·3	—	63·9	35·9	—
26	42·3	30·8	·19	49·9	36·0	·21	52·1	33·5	·15	52·8	43·8	—
27	**46·9**	32·6	—	50·7	38·2	·04	58·2	38·4	—	56·1	42·9	—
28	46·1	39·5	·03	53·1	44·5	—	56·8	44·3	—	51·1	40·1	—
29	36·9	28·0	—				54·0	41·5	·16	51·8	36·2	—
30	37·0	29·0	·01				49·1	35·4	·04	57·1	40·1	·07
31	36·3	29·3	—				60·9	40·3	—			
Mean	45·8	36·8	0·70	39·7	30·2	0·83	52·5	38·1	1·74	54·8	39·3	0·69

Note.—The highest observation in each monthly column is underlined, and the lowest placed within brackets.

The records shown in thicker type correspond to the dates of collection of the various of samples soil.

I am indebted for these records to the kindness of Mr. Campbell Bayard.

No. 7.

APP. B, No. 7.

On the Chemical and Bacteriological Examination of Chichester Well Water; by Dr. Houston.

FURTHER REPORT on CHEMICAL and BACTERIOLOGICAL EXAMINATION of CHICHESTER WELL WATER; by DR. A. C. HOUSTON.

During 1899–1900, a preliminary study was made of the chemical and bacteriological characters of soils obtained from the "fever" and "non-fever" areas at Chichester. The results of this preliminary investigation did not point to the fever area soils being in chemical and bacterial composition widely different from the soils obtained from the non-fever areas or from soils, elsewhere than at Chichester, in the vicinity of dwellings of a similar class. The scheme of inquiry had, therefore, to be modified. Instead of attempting to determine directly the viability of the typhoid bacillus in Chichester soil *in situ*, when added artificially thereto in gross amount, this problem was attacked indirectly, and investigation undertaken for determining :—

(a.) *The vitality of sewage microbes in soil* artificially polluted with sewage ; and

(b.) *the chemical and bacterial composition of Chichester subsoil water.*

Both these subjects were reported on in last year's volume (1900–1901, App. B, Nos. 4 and 6), and their bearing (in general and in particular cases, as at Chichester) on the occurrence of enteric fever attributed to the pollution of soil and subsoil water with sewage was fully commented on.

As regards (a) *the vitality of sewage microbes in soil artificially polluted with sewage*, last year's work (1900–1) may be briefly summarised as follows :—

The *absolute* disappearance of microbes seemingly akin to B. coli from soil previously polluted with sewage was by no means always established, although the soil was kept under observation for weeks and even months. But the *relative* disappearance of B. coli (and closely allied forms) from the polluted soil was usually clearly indicated, and the death of streptococci with decline also in the number of gas-forming and indol-producing bacteria, subsequent to cessation of the sewage inoculations of the soil, was also established. Moreover, there was no indication that the sewage microbes of non-sporing kind multiplied and throve in the soil at the expense of the bacteria proper (peculiar, as it were) to the soil itself. On the contrary, the soil bacteria appeared to oust in the struggle for existence the more delicate sewage microbes.

This year (1901–2) the subject has been further studied, and the results, which mainly confirm the statements in the foregoing summary, are reported on in this volume.

As regards study of (b.) *the chemical and bacterial composition of Chichester subsoil water*, last year's work (1900–1) may be best

summarised by repeating the final conclusions, namely, as follows:—

A.—Chemical.

None of the 30 samples of Chichester well water could reasonably have been condemned on the basis of the free ammonia, albuminoid ammonia, or oxygen absorbed from permanganate tests. Nearly all of them would have been classed as of great organic purity, though the amount of chlorine in a number of samples was perhaps ground for suspicion.

B.—Bacteriological.

(1.) The general results and inferences are as follows:—

(a.) *Total number of bacteria per cc.*:—In 3 samples, 1,000 but less than 10,000; in 13 samples, 100 but less than 1,000; in 11 samples, 10 but less than 100; in 3 samples, less than 10.

(b.) "*Gas*" *in gelatine* "*shake*" *cultures* (24 hours at 20° C.).—In 2 samples, + 10 cc. — 1 cc; in 6 samples, + 100 cc. — 10 cc.; in 22 samples, — 100 cc.

(c.) *B. coli (and allied forms).*—In 6 samples, + 0·1 cc.; in 6 samples, + 10 cc. — 0·1 cc.; in 10 samples, + 100 cc. — 10 cc.; in 8 samples, — 100 cc.

(d.) *Spores of B. enteritidis sporogenes* (Klein).—In 2 samples, + 100 cc. — 10 cc.; in 2 samples, + 200 cc. — 100 cc.; in 26 samples, — 200 cc.

(e.) *Streptococci.*—In 5 samples, + 10 cc.; in 25 samples, — 10 cc.

(2.) These general results may be interpreted as indicating nothing more than that some of the waters were polluted and that others were of great bacterial purity.

(3.) But it may be questioned whether they do not indicate something more than this, namely, that the waters in general were possessed of intrinsic biological qualities pointing to their late association with matters of intestinal sort.

(4.) Biological qualities such as the above are not proper to waters derived from pure sources; moreover, they are apt to be masked chemically by the mechanical filtering action of the soil.

(5.) If this view be correct, immunity from danger in drinking such waters would be relative, not absolute.

(6.) The circumstance that the inhabitants of Chichester, who derive their water supply from these local wells, have not seemingly suffered to any conspicuous extent from enteric fever in the past, may possibly be referred, not to the complete absence of dangerous pollution of well waters, but to the beneficial mechanical action of the soil in reducing the amount of morbific poison contained in the soil water.

(7.) The facts observed by me at Chichester lend some support to Dr. Thomson's tentative hypothesis that soil plays some part in "fostering and localising" enteric fever in this town, inasmuch as the well waters representing the more or less perfectly filtered "washings" of soil, nevertheless possessed certain biological qualities suggestive of fouling with matters of intestinal outcome. Qualities not inconsistent with the supposition that possibly the soil at Chichester fosters in a higher degree than most soils "the vitality and morbific power of the infective material of enteric fever."

(8.) B. typhosus could not be found in any of the samples examined. But B. coli (or closely allied forms) was found in a majority of the waters; and, further, a small percentage of these coli-like microbes gave a positive result with the agglutination test, with human typhoid blood, with the blood of a typhoid immunised guinea-pig, or with blood of both sorts.

App. B, No. 7.
On the Chemical and Bacteriological Examination of Chichester Well Water; by Dr. Houston.

This year (1901–2) the (*b*), bacteriological section of the subject has been further studied, and the results obtained agree pretty closely with my previous work. Dr. Thomson's report was so fully discussed last year (in so far as it bore or seemed to bear on my experimental work) that it does not seem necessary to reconsider the question from this point of view, except incidentally and with a view to supporting or modifying previous provisional inferences. Further, the general characters of the soil and subsoil water and other considerations bearing on the question have been already dealt with in detail so that it is not necessary again to discuss them.

It will be remembered that in last year's work 30 samples were examined from 14 different sources. Of these 10 were from reputed fever areas and four from non-fever areas. This year, owing to the active assistance and co-operation of Mr. Saunders, the city surveyor, it became possible to obtain samples from 10 "fever area" and 10 "non-fever area" closed pump wells. In respect of the class of property in the immediate neighbourhood of these wells, the samples from the fever and non-fever areas respectively were obtained under conditions sufficiently similar to render a general comparison between the two classes of samples reliable.

The lines of experimental work were very similar to those adopted during the previous year; but, in addition, a special series of observations were carried out in the endeavour to isolate the typhoid bacillus from the implicated waters. That portion of the work which corresponded to last year's research will be spoken of as Part I., and the new part above alluded to as Part II. Part III., deals with conclusions and recommendations arising out of the inquiry.

The following is a summary of the several sections of this report :—

Part I.

I.—Description of the samples of water, with account of the chemical and bacteriological methods adopted in the investigation.

II.—Results of chemical examination of the waters.

(1.) Free ammonia.

(2.) Albuminoid ammonia.

(3.) Oxygen absorbed from permanganate,

(4.) Chlorine.

III.—Results of bacteriological examination of the waters.

(1.) Total number of bacteria (gelatine at 20° C.).

(2.) "Gas" in gelatine "shake" cultures (24 hours at 20° C.).

(3.) B. coli (and allied forms), and search for B. typhosus, in—

(a) 0·1 cc.
(b) 1·0 cc.
(c) 10 cc. } Pasteur "filter brushing"
(d) 100 cc. } method.
(e) Analysis of the coli-like microbes isolated from the various samples of well water.

(4) Spores of B. enteritidis sporogenes (Klein).

(5) Streptococci.

IV.—General summary of the chemical and bacteriological results.

PART II.

I.—Results of a special examination of the well water from the reputed fever areas for the presence of B. typhosus.

II.—Description of the methods adopted in this part of the investigation.

III.—Analysis of the microbes which on preliminary observation in the plate culture could not without further study be said not to be B. typhosus.

PART III.

A.—Final conclusions.

B.—Recommendations.

PART I.

I. Description of Water Samples and of Methods adopted for their Investigation.

(a.) *The samples of well water submitted to chemical and bacteriological examination.*

The following (Table 1) gives a brief description of the various samples.

TABLE 1.

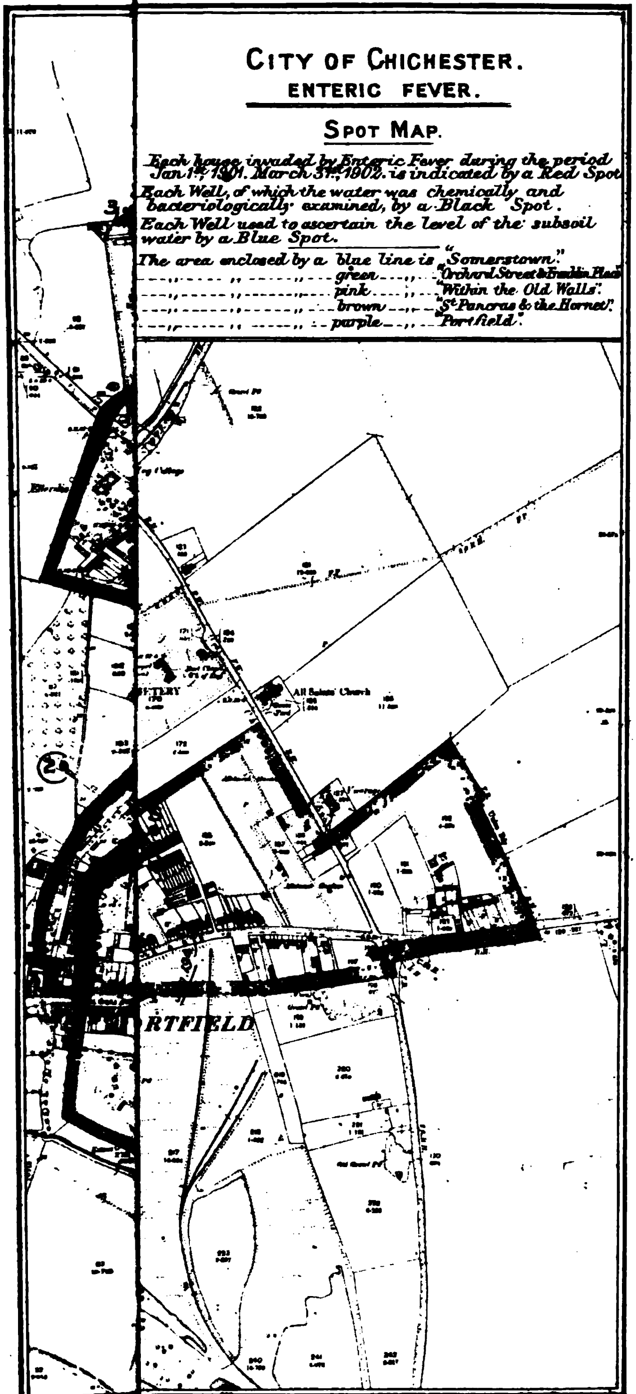
Description of the Sample.	Date of Collection of the Sample.	Reputed "Fever" or "Non-fever" Area.
Sample O^1, 2, Stirling Road*	September 30th, 1901	Non-fever.
" P^1, 120, St. Pancras	" "	Fever.
" Q^1 (I of last year), 27, Chapel Street ..	October 7th, 1901 ..	Fever.
" R^1 (K of last year, but called fever), 7, 8, 9, Chapel Street.	" " ..	Non-fever.
" S^1 (L of last year), 52, Victoria Road ..	" 14th, 1901 ..	Fever.
" T^1 (D of last year), Cattle Market ..	" " ..	Non-fever.
" U^1 (H of last year), 16, St. Pancras ..	" 21st, 1901 ..	Fever.
" V^1, 39, Bognor Road	" " ..	Non-fever.
" W^1 (G of last year), 2, North Gate ..	" 28th, 1901 ..	Fever.
" X^1, 1, 2, 3, Basin Cottages	" " ..	Non-fever.
" Y^1, 32, Orchard Terrace	November 4th, 1901	Fever.
" Z^1, 2, Southgate	" "	Non-fever.
" $[1]^1$, 18, Washington Street	" 11th, 1901	Fever.
$[2]^1$, Cottage in Orchard Path	" "	Non-fever.
" $[3]^1$, Mill House, St. Paul's Road ..	" 18th, 1901	Fever.
" $[4]^1$, 10, Northgate	" "	Non-fever.
" $[5]^1$, 13, Washington Street	" 25th, 1901	Fever.
" $[6]^1$, 2, Oakland Cottage	" "	Non-fever.
" $[7]^1$, 1, Cavendish Street	December 2nd, 1901	Fever.
" $[8]^1$, Blacksmith's Shop, Northgate ..	" "	Non-fever.

* The topographical position of the wells is shown on a map accompanying this report.

(b.) The various methods used in the chemical and bacteriological examination of the samples of water.

Collection of samples.—The samples were collected in sterile bottles, and the pump* was worked for some considerable time before collecting the sample. The waters were examined as soon after collection as possible.

* All the samples were obtained from pump closed wells.



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This year (1901–2) the (*b*), bacteriological section of the subject has been further studied, and the results obtained agree pretty closely with my previous work. Dr. Thomson's report was so fully discussed last year (in so far as it bore or seemed to bear on my experimental work) that it does not seem necessary to reconsider the question from this point of view, except incidentally and with a view to supporting or modifying previous provisional inferences. Further, the general characters of the soil and subsoil water and other considerations bearing on the question have been already dealt with in detail so that it is not necessary again to discuss them.

It will be remembered that in last year's work 30 samples were examined from 14 different sources. Of these 10 were from reputed fever areas and four from non-fever areas. This year, owing to the active assistance and co-operation of Mr. Saunders, the city surveyor, it became possible to obtain samples from 10 "fever area" and 10 "non-fever area" closed pump wells. In respect of the class of property in the immediate neighbourhood of these wells, the samples from the fever and non-fever areas respectively were obtained under conditions sufficiently similar to render a general comparison between the two classes of samples reliable.

The lines of experimental work were very similar to those adopted during the previous year; but, in addition, a special series of observations were carried out in the endeavour to isolate the typhoid bacillus from the implicated waters. That portion of the work which corresponded to last year's research will be spoken of as Part I., and the new part above alluded to as Part II. Part III., deals with conclusions and recommendations arising out of the inquiry.

The following is a summary of the several sections of this report:—

Part I.

I.—Description of the samples of water, with account of the chemical and bacteriological methods adopted in the investigation.

II.—Results of chemical examination of the waters.

(1.) Free ammonia.

(2.) Albuminoid ammonia.

(3.) Oxygen absorbed from permanganate.

(4.) Chlorine.

PART I.

I. Description of Water Samples and of Methods adopted for their Investigation.

(a.) *The samples of well water submitted to chemical and bacteriological examination.*

The following (Table 1) gives a brief description of the various samples.

TABLE 1.

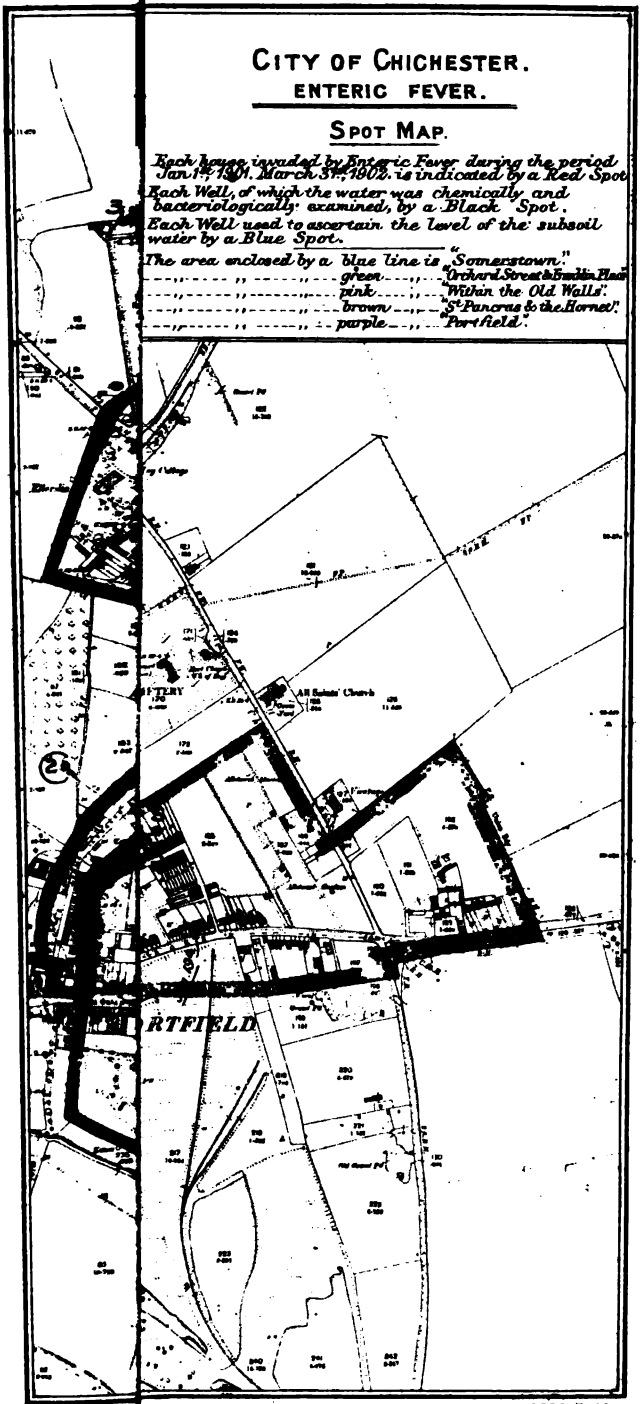
Description of the Sample.	Date of Collection of the Sample.	Reputed "Fever" or "Non-fever" Area.
Sample O¹, 2, Stirling Road*	September 30th, 1901	Non-fever.
" P¹, 120, St. Pancras	" "	Fever.
" Q¹ (I of last year), 27, Chapel Street ..	October 7th, 1901 ..	Fever.
" R¹ (K of last year, but called fever), 7, 8, 9, Chapel Street.	" " ..	Non-fever.
" S¹ (L of last year), 52, Victoria Road ..	" 14th, 1901 ..	Fever.
" T¹ (D of last year), Cattle Market ..	" " ..	Non-fever.
" U¹ (H of last year), 16, St. Pancras ..	" 21st, 1901 ..	Fever.
" V¹, 39, Bognor Road	" " ..	Non-fever.
" W¹ (G of last year), 2, North Gate ..	" 28th, 1901 ..	Fever.
" X¹, 1, 2, 3, Basin Cottages	" " ..	Non-fever.
" Y¹, 32, Orchard Terrace	November 4th, 1901	Fever.
" Z¹, 2, Southgate	" "	Non-fever.
" [1]¹, 18, Washington Street	" 11th, 1901	Fever.
[2]¹, Cottage in Orchard Path	" "	Non-fever.
" [3]¹, Mill House, St. Paul's Road ..	" 18th, 1901	Fever.
" [4]¹, 10, Northgate	" "	Non-fever.
" [5]¹, 13, Washington Street	" 25th, 1901	Fever.
" [6]¹, 2, Oakland Cottage	" "	Non-fever.
" [7]¹, 1, Cavendish Street	December 2nd, 1901	Fever.
" [8]¹, Blacksmith's Shop, Northgate ..	" "	Non-fever.

* The topographical position of the wells is shown on a map accompanying this report.

(b.) The various methods used in the chemical and bacteriological examination of the samples of water.

Collection of samples.—The samples were collected in sterile bottles, and the pump* was worked for some considerable time before collecting the sample. The waters were examined as soon as after collection as possible.

* All the samples were obtained from pump closed wells.



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Chemical Examination.

No elaborate chemical analyses were carried out, but all the waters were examined for (*a*) free ammonia, (*b*) albuminoid ammonia, (*c*) oxygen absorbed from permanganate, and (*d*) chlorine. These processes are too well known to require further consideration. There are other and possibly better methods of chemical analysis which might have been employed, but my chief object in making a chemical examination at all was to obtain some records relating to the amount of organic matter present in the well waters, and to place these side by side with the obviously more important bacteriological data. Moreover, the results obtained by one or another chemical method seem to me to differ but slightly, and the advantage claimed now for one now for another test is almost trivial in character considering the serious intrinsic limitations of chemical investigations in their relation to water supply. At all events, the fact that chemists are by no means in agreement as to the best mode of chemically examining potable waters would seem to indicate that some latitude is permissible in selecting chemical processes for adoption in a particular investigation.

Bacteriological Examination.

All the waters, without exception, were filtered through a sterilised Pasteur filter. The surface of the filter was brushed with a sterile brush, with 10 cc. of sterile water. 1,000 cc. of the water under examination were used in each case, so that each cc. of the filter brushing suspension was approximately representative of the bacterial contents of 100 cc. of the original water. This procedure made the work more laborious, but it also made the results more valuable. Comparatively few determinations of this sort may yield more valuable information than a great number carried out under the ordinary conditions of experiment. Direct cultures (*i.e.*, cultivations made directly from the water without previous filtration) were, of course, also made.

Total number of bacteria (gelatine, at 20° C.).—These were made direct from the water in the usual manner.

"*Gas*" *in gelatine* "*shake*" *cultures* (24 hours, at 20° C.).—As a rule, two 10 cc. gelatine tubes were inoculated, the one with 1 cc. (= 100 cc. of the original water), the other with 0·1 cc. (= 10 cc. of the original water), of the "filter brushing." The tubes were placed in warm water (about 35 to 40° C.) for a few minutes to melt the gelatine; then shaken to mix the contents together; placed in cold water to allow the gelatine to become solid again; and finally placed in the cool incubator (20° C.) for 24 hours.

It needs to be pointed out that a negative result does not necessarily imply complete absence of gas forming bacteria, even when a considerable amount of the water ("filter brushing" method) is added to the gelatine. One reason is that the production of gas is largely dependent on the presence of B. coli and B. proteus and their allies, and that a certain number of these microbes are necessary to produce a visible development of gas in gelatine "shake" culture in a reasonable time. The test may be rendered more delicate by extending the incubation to 48 hours, but for various reasons this is not recommended. The test, indeed, is more valuable in its positive aspects, and in connection with the examination of impure waters and sewage effluents. Speaking from the results of a long series of observations, it may be said that usually crude sewage gives a positive result within 24 hours, even with so small an amount as $\frac{1}{1000}$ cc. These well waters, as will be presently seen, usually gave a negative result, even with the bacterial contents of as much as 100 cc. ("filter-brushing" method).

B. coli (and closely allied forms), and search for B. typhosus.—Both surface phenol (0·05 per cent.), gelatine plate, and phenol (0·05 per cent.) broth cultures were used. The former were incubated at 20° C. and the latter at 37° C. The broth cultures, after incubation at 37° C. for 24–48 hours were used for making surface phenol (0·05 per cent.) gelatine plate cultures. The amount of water used varied; but usually cultures were made containing 0·1 cc. and 1 cc. direct, and 0·1 cc. (= 10 cc. of the original water) and 1·0 cc. (= 100 cc.) of the "filter brushing."

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These cultivations, as well as ordinary gelatine plates and surface agar plates, were strictly searched for the presence of B. typhosus. But the results were uniformly negative.

Eighty-one microbes were made the subject of more or less attentive study These were sub-cultured either because they resembled B. coli or B. typhosus, or because, at the particular stage of observation, their identity with either the one or the other was uncertain.

None of these colonies proved to be B. typhosus, and some of them showed no sort of kinship to B. coli; but the majority of the colonies were to be thought of as those of B. coli, or more or less closely related forms. It was necessary, of course, not only to search for B. typhosus but also for B. coli, because the presence of the latter in any number must be regarded as an index of the possibility of the occurrence at some time or other of the former. It was not anticipated, although prolonged search was made with this object, that B. typhosus would be found in the well waters.

The presence of B. typhosus in these waters could only be thought of as likely to be very exceptional, and its numbers, if present, to be extremely small; so that it was the more necessary to fall back upon determination of the presence (and, if present, the relative abundance) or absence (and, if absent, from what amount) of some microbe of intestinal sort (*e.g.*, B. coli) as a means of measuring the degree of potential harmfulness of the well waters. As regards the relative values of gelatine plates and broth cultures, with subsequent plating, I am in some doubt. Unquestionably the gelatine plates enable a large number of different strains of coli-like microbes to be studied, whereas the broth cultures tend to "draw out," so to speak some one particular strain of B. coli at the expense of all other strains.

As regards B. typhosus, it is usually held that, as it is likely to be present in very small number, primary gelatine plates are not nearly so valuable as secondary ones (that is, plates made from primary broth cultures). The idea being that B. typhosus multiplies in the broth to an extent allowing of its subsequent isolation from the plates made from the broth culture. This, of course, is quite true, but as B. coli is always likely to be present as well, and in greater numbers (an initial advantage to this microbe), and as it multiplies at a much greater rate (an inherent advantage possessed by B. coli) than B. typhosus, the especial value to the investigator of the broth method may not be real. And every hour delayed in making plates from the broth cultures may actually diminish instead of increasing the chances of ultimately isolating the B. typhosus; for the reason that, although the broth method would undoubtedly lead to an increase in the number of typhoid bacilli, it might actually diminish their number relative to the total number of other microbes also present. However this may be, I made full use of both these methods. As regards agar cultures, my own experience has been that most microbes (and perhaps especially B. coli) grow in a more characteristic fashion in gelatine than in agar cultivations. But this opinion is by no means shared by all bacteriologists. As a matter of fact most of the Chichester waters yielded a very small crop of colonies in the agar cultures, even when 0·1 cc. of the 10 cc. "filter brushing" of 1,000 cc. was employed.

Spores of B. enteritidis sporogenes (Klein).—Sterile milk tubes were inoculated severally with 0·1 cc. (= 10 cc. of original water), 1·0 cc. (= 100 cc.), and 2·0 cc. (= 200 cc.), of a 10 cc. "filter brushing" of 1,000 cc. of the water. After heating to 80° C. for 10 minutes the milk tubes were placed in wide-mouthed and stoppered tubes containing a freshly prepared mixture of pyrogallic acid and potassium hydrate solution, and incubated at 37° C. for 48 hours. Preparatory to use, the milk tubes were boiled for half an hour and then quickly cooled. This procedure is very necessary; and it is equally important to extend the time of observation of the milk cultures to 48 hours if the results are negative in 24 hours.

Streptococci.—Surface agar plate cultures, incubated at 37° C., were used Usually the plates were inoculated with 0·1 cc. (= 10 cc.) of a 10 cc. "filter brushing" of 1,000 cc. of the original water. The minute colonies were subcultured in broth (incubated at 37° C.), and if a microscopic examination of the resulting growth proved satisfactory they were further studied in litmus milk, and other media.

II.—Results of the Chemical Examination of Twenty Samples of Chichester Well Water obtained from Twenty Different Sources.

The chemical results are given in the following table :—

Table 2.

Showing the Results of the Chemical Examination of Twenty Samples of Chichester Well Water obtained from twenty different sources, as regards the amount of Free and Albuminoid Ammonia, Oxygen absorbed from Permanganate, and Chlorine.

[Results stated as parts per 100,000.]

Description of the Sample of Water.	Free Ammonia.	Albuminoid Ammonia.	Oxygen absorbed from Permanganate (4 hours at the room temperature).	Chlorine.
Sample O^1, 2, Stirling Road. September 30th, 1901.	Traces.	·004	Traces.	2·8
" P^1, 120, St. Pancras. September 30th, 1901.	"	·004	"	2·4
" Q^1, 27, Chapel Street. October 7th, 1901.	"	·0032	"	2·3
" R^1, 7, 8, 9, Chapel Street. October 7th, 1901.	"	·004	"	2·8
" S^1, 52, Victoria Road. October 14th, 1901.	"	·004	"	2·0
" T^1, Cattle Market. October 14th, 1901.	"	·004	·01	3·9
" U^1, 16, St. Pancras. October 22nd, 1901.	"	·0024	Traces.	2·4
" V^1, 39, Bognor Road. October 22nd, 1901.	"	·0064	"	2·2
" W^1, 2, Northgate. October 28th, 1901.	"	·004	"	2·1
" X^1, Basin Cottages. October 28th, 1901.	"	·0032	·014	2·2
" Y^1, 32, Orchard Terrace. November 4th, 1901.	"	·0064	Traces.	4·2
" Z^1, 2, Southgate. November 4th, 1901.	·0016	·0104	·0476	3·6
" $[1]^1$, 18, Washington Street. November 11th, 1901.	1·28	·02	·031	4·5
" $[2]^1$, Cottage Orchard Path. November 11th, 1901.	·0024	·0056	·009	5·8
" $[3]^1$, Mill House. November 18th, 1901.	·0024	·0056	Traces.	2·4
" $[4]^1$, 10, Northgate. November 18th, 1901.	·0016	·0056	·012	3·3
" $[5]^1$, 13, Washington Street. November 25th, 1901.	3·6	·048	·035	7·5
" $[6]^1$, 2, Oaklands. November 25th, 1901.	·0104	·0064	Traces.	4·
" $[7]^1$, 1, Cavendish Street. December 2nd, 1901.	·048	·0064	"	5
" $[8]^1$, Blacksmith's Shop. December 2nd, 1901.	·0032	·0056	"	2·9

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(1.) *Free ammonia.*—It will be noted that in the case of the majority of the samples the relative absence of free ammonia was conspicuous. The most notable exceptions were [1]' and [5]' in which the amount was excessive. That these particular well waters had been polluted with matter of animal outcome is very probable.

(2.) *Albuminoid ammonia.*—Adopting the general view that a good drinking water should not contain more than 0·008 parts per 100,000 of albuminoid ammonia, it is to be noted that only three samples could have been condemned on the basis of this test alone, namely, Z', [1]', and [5]'.

(3.) *Oxygen absorbed from permanganate.*—None of the waters, as judged by this test, could be regarded as other than of great organic purity. The results, when considered in conjunction with the chlorine and other chemical records, lead one to doubt if this test can be relied on in all cases.

(4.) *Chlorine.*—The chlorine figures were of some interest. As 11 out of 20 samples yielded between 2 and 3 parts of chlorine per 100,000, and as in 8 of these the figures were nearer 2 than 3 parts, it probably would be a moderate estimate to regard over 3 parts as suspicious. In this view of the case, samples T', Y', Z', [1]', [2]', [4]', [5]', [6]', and [7]' would all come under the ban of suspicion. Samples [5]', [2]', [7]', [1]', and [6]' contained respectively 7·5, 5·8, 5·1, 4·5, and 4·3 parts of chlorine, and two of these [5]' and [1]' yielded also very high figures as regards free and albuminoid ammonia. Chemists are by no means agreed as to the amount of chlorine in shallow well waters which may reasonably be regarded as naturally present (proper, that is, to the strata from which water is derived), and which, therefore, need not excite any suspicion of objectionable contamination. Nor is this surprising considering the wide difference in the amount of chlorine observed in wells seemingly unpolluted in different localities. Indeed, each and every case must be judged on its own merits, the chlorine figures being interpreted in the light of a knowledge of the local conditions, and in relation to the other chemical data. But when, as in the present case, a number of wells of approximately the same depth and mode of construction are situated within a measurable distance of each other, and show such variations as from 2·0, S' to 7·5, [5]', the inference is of a strong kind that the wells yielding high figures are liable to pollution of animal sort.

Comparing this year's work with that of the previous year, it must be remembered that a few of the wells were no longer available for obtaining samples, and also that a considerable number of new wells was added to the list. These facts being borne in mind, the general agreement between the results is worthy of note. Briefly stated, such a comparison shows that in each year the majority of samples examined yielded results unequivocally good. But unquestionably the results of this year's work tended more than those of the preceding year to show that not all the well waters were free from suspicion of dangerous fouling with matters probably of recent animal outcome.

III.—Results of the Bacteriological Examination of Twenty Samples of Chichester Well Water obtained from Twenty Different Sources.

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(1.) *Total number of bacteria* (gelatine at 20° C.). The results obtained are shown in Table 3.

Table 3.

Showing as regards total number of bacteria in 1 cc. (gelatine at 20° C.) the results of the bacteriological examination of 20 samples of Chichester well water obtained from 20 different sources.

Description of the Sample of Water.	Total Number of Bacteria in 1 cc. (Gelatine at 20° C.)
Sample O^1, 2, Stirling Road. September 30th, 1901	1
" P^1, 120, St. Pancras. September 30th, 1901	30
" Q^1, 27, Chapel Street. October 7th, 1901	71
" R^1, 7, 8, 9, Chapel Street. October 7th, 1901	296
" S^1, 52, Victoria Road. October 14th, 1901	270
" T^1, Cattle Market. October 14th, 1901	140
" U^1, 16, St. Pancras. October 22nd, 1901	160
" V^1, 39, Bognor Road. October 22nd, 1901	10
" W^1, 2, Northgate. October 28th, 1901	280
" X^1, Basin Cottages. October 28th, 1901	1,080
" Y^1, 32, Orchard Terrace. November 4th, 1901	880
" Z^1, 2, Southgate. November 4th, 1901	3,440
" $[1]^1$, 18, Washington Street. November 11th, 1901 ...	1,920
" $[2]^1$, Cottage Orchard Path. November 11th, 1901 ...	2,400
" $[3]^1$, Mill House. November 18th, 1901	1,680
" $[4]^1$, 10, Northgate. November 18th, 1901	1,840
" $[5]^1$, 13, Washington Street. November 25th, 1901 ...	264
" $[6]^1$, 2, Oaklands. November 25th, 1901...	1,320
" $[7]^1$, 1, Cavendish Street. December 2nd, 1901 ...	60
" $[8]^1$, Blacksmith's Shop. December 2nd, 1901	107

It will be seen from the table that of these 20 samples five (O[1], P[1], Q[1], V[1], [7][1]) yielded less than 100 microbes per cc. Seven samples (R[1], S[1], T[1], U[1], W[1], [5][1], [8][1]) contained over 100, but less than 500, and one sample [Y][1] between 500 and 1,000 bacteria in 1 cc. The remaining seven samples (X[1], Z[1], [1][1], [2][1], [3][1], [4][1], [6][1]) contained more than 1,000, but less than 4,000 microbes per cc.

On the basis of this test without any knowledge of the circumstances of the water supply—and tentatively regarding less than 100 as indicating a pure, and less than 500 a fairly pure, between 500 and 1,000 as suspicious, and over 1,000 bacteria per cc. (gelatine at 20° C.) a bad water—then rather more than half (12 out of 20) the samples were satisfactory.

As regards the sorts of bacteria met with in the cultures, the microbes of coli-like appearance will be considered in a separate section. Excluding these coli-like microbes, no special study was made of the kinds of microbes present in the well waters. But, of course, such "water microbes" as the fluorescent bacteria ~~(liquefying and non-liquefying), and B. arborescens were con-~~ stantly found in the cultures. B. mycoides, the *granular* bacillus of soil, and cladothrix were relatively absent. These microbes notwithstanding their abundance in superficial soil, are not commonly found in water cultures. Their presence in water in any number always points, in my experience, to *soil disturbance* of one sort or other, *e.g.*, flood water.

(2.) "*Gas*" *in gelatine* "*shake cultures*" (24 hours at 20° C.).

The results obtained were chiefly of a negative character, they are shown in Table 4.

TABLE 4.

Showing as regards the "gas" test the results of the bacteriological examination of 20 samples of Chichester well water obtained from 20 different sources.

Description of the Sample of Water.	"Gas" in Gelatine Shake Culture (24 hours at 20° C.).	
	10 cc.*	100 cc.§
Sample O[1], 2, Stirling Road. September 30th, 1901 ...	—	—
" P[1], 120, St. Pancras. September 30th, 1901 ...	—	—
" Q[1] 27, Chapel Street. October 7th, 1901 ...	—	—
" R[1], 7, 8, 9, Chapel Street. October 7th, 1901 ...	—	—
" S[1], 52, Victoria Road. October 14th, 1901 ...	—	—

* 0·1 cc. of a 10 cc. "filter brushing" of 1,000 cc. (= 10 cc. of original water).
§ 1·0 " " " " (= 100 cc. ").

TABLE 4—*continued.*

Description of the Sample of Water.	"Gas" in Gelatine Shake Culture (24 hours at 20° C.).	
	10 cc.*	100 cc.§
Sample T[1], Cattle Market. October 14th, 1901	—	—
" U[1], 16, St. Pancras. October 22nd, 1901 ...	—	—
" V[1], 39, Bognor Road. October 22nd, 1901 ...	—	—
" W[1], 2, Northgate. October 28th, 1901	—	—
" X[1], Basin Cottages. October 28th, 1901... ...	—	—
" Y[1], 32, Orchard Terrace. November 4th, 1901 ...	—	—
" Z[1], 2, Southgate. November 4th, 1901	—	—
" [1][1], 18, Washington Street. November 11th, 1901.	—	—
" [2][1], Cottage Orchard Path. November 11th, 1901.	—	—
" [3][1], Mill House. November 18th, 1901 ...	—	+
" [4][1], 10, Northgate. November 18th, 1901 ...	—	+
" [5][1], 13, Washington Street. November 25th, 1901.	—	—
" [6][1], 2, Oaklands. November 25th, 1901 ...	—	—
" [7][1], 1, Cavendish Street. December 2nd, 1901	—	—
" [8][1], Blacksmith's Shop. December 2nd, 1901...	—	—

* 0·1 cc. of a 10 cc. "filter brushing" of 1,000 cc. (=10 cc. of original water).
§ 1·0 " " " " (=100 cc. " ").

It will be seen that no less than 18 out of the 20 samples failed to give a positive result, even when the bacterial contents of 100 cc. were added to the gelatine. In its negative aspects this test, even when dealing with the bacterial contents of a large bulk of water, is not necessarily a safe indication of wholesomeness. A considerable number of gas-forming bacteria must needs be present in the amount of water used for cultural purposes in order to produce a visible development of gas in gelatine shake cultures within 24 hours. It is in its positive aspects and in connection with the bacteriological examination of sewage, sewage effluents, and impure waters that the test is of special value. The wide distinction between the above results and the results obtained in the

examination of crude sewage is worth noting Crude sewage nearly always gives a positive result with $\frac{1}{1000}$ cc., whereas 18 out of the 20 samples of well water yielded a negative result with 100 cc.

(3.) *B. coli (and closely allied forms), and search for B. typhosus.*—The work carried out under this heading was of an extensive character, and must needs be considered in separate sections.

It is convenient to consider in the first place the series of experiments in which surface gelatine plate cultures [(a) 0·1 cc. and (b) 10 cc. of the water] were used, and afterwards those in which primary broth cultures and secondary, gelatine plate cultures [(c) 1 cc.; (d) 10 cc.; (e) 100 cc. of the water] were employed.

(a.) *Presence or absence of B. coli in* 0·1 *cc. Surface phenol* (0·05 *per cent.) gelatine plate cultures.*—The results are shown in Table 5.

Table 5.

Showing as regards presence or absence of B. coli (or allied forms) in 0·1 cc. the results of the bacteriological examination of 30 samples of Chichester well water, obtained from 20 different sources.

[Surface phenol gelatine plate method].

Sample O^1	-	No growth in plate.
„ P^1	-	No sub-cultures made; no colonies like B. coli.
„ Q^1	-	„ „ „
„ R^1	-	„ „ „
„ S^1	+	*See* Microbe 18, table 10 (B. coli or allied form); also microbe 17: (no kinship to B. coli).
„ T^1	-	No sub-cultures made; no colonies like B coli.
„ U^1	+	*See* Microbe 28, table 10 (B. coli or allied form); also microbe 30 (no kinship to B. coli.)
„ V^1	-	No sub-cultures made; no colonies like B. coli.
„ W^1	+	*See* Microbe 36, table 10 (B. coli or allied form).
„ X^1	-	„ 38, table 10 (no kinship to B. coli).
„ Y^1	-	„ 45, table 10 (no kinship to B. coli).
„ Z^1	-	No sub-cultures made; no colonies like B. coli.
„ $[1]^1$ ..	-	*See* Microbe 53, table 10 (no kinship to B. coli).
„ $[2]^1$ ..	-	„ 55, table 10 (no kinship to B. coli).
„ $[3]^1$ ..	-	No sub-cultures made; no colonies like B. coli.
„ $[4]^1$ ..	?+	*See* Microbe 61, table 10 (? B. coli or allied form).
„ $[5]^1$ ..	-	„ 70, table 10 (no kinship to B. coli).
„ $[6]^1$ ..	-	„ 72, table 10 (no kinship to B. coli).
„ $[7]^1$.	-	No sub-cultures made; no colonies like B. coli.
„ $[8]^1$ ..	-	„ „ „ „

It will be noted that four (S^1, U^1, W^1, and [4^1]) out of the twenty samples of water yielded coli-like microbes in 0·1 cc. The remaining sixteen samples either showed no colonies resembling B. coli in the 0·1 cc. plate cultures; or, any colonies simulating B. coli on preliminary observation in the plate cultivations were found on further investigation to bear no close kinship to B. coli.

Without raising the vexed question of standards, it is permissible to say that there seems no justification for "passing" a water containing in 0·1 cc. microbes seemingly closely akin to B. coli when bacteria of comparable sort may be wholly absent from 1, 10, or even 100 cc. of other waters of less suspicious sort.

(b.) *Presence or absence of B. coli in* 10 *cc. surface phenol* (0·05 *per cent.*) *gelatine plate cultures.*—The results are shown in Table 6.

TABLE 6.

Showing as regards presence or absence of B. coli (or allied forms) in 10 cc.* the results of the Bacteriological Examination of 20 samples of Chichester well water obtained from 20 different sources.

[Surface phenol gelatine plate method.]

Sample O^1	-	No sub-cultures made; no colonies like B. coli.
" P^1	+	*See* Microbes 3 (B. coli or allied form), 4 (? ally of B. coli); microbes 1, 2 (no kinship to B. coli), table 10.
" Q^1	-	*See* Microbes 9 and 10, table 10 (no kinship to B. coli).
" R^1	?+	*See* Microbe 13 (some kinship to B. coli) and 14 (no kinship to B. coli) table 10.
† " S^1	-	" 19 (no kinship to B. coli), table 10.
" T^1	+	*See* Microbes 23 and 24 (B. coli or allied form), table 10.
" U^1	+	*See* Microbe 29 (B. coli or allied form) table 10.
" V^1	-	No sub-cultures made; no colonies like B. coli.
" W^1.. ..	?+	*See* Microbe 37 (some kinship to B. coli), table 10.

* 0·1 cc. of a 10 cc. "filter brushing" of 1,000 cc. of the original water. Pasteur "filter brushing" method.

† In the case of this sample a positive result was obtained with 0·1 cc. of the water. (*See* previous table.)

TABLE 6—*continued.*

Sample X¹ ..	..	-	*See* Microbe 39 (no kinship to B. coli), table 10.
" Y¹ ..	..	?+	" 46 (some kinship to B coli), table 10.
" Z¹ ..	..	-	No sub-cultures made; no colonies like B. coli.
" [1]¹	..	-	*See* Microbe 54 (no kinship to B. coli), table 10.
" [2]¹	..	?+	" 56 (some kinship to B. coli), table 10.
" [3]¹	..	-	" 62 (no kinship to B. coli), table 10.
" [4]¹	..	?+	" 63 (? B. coli or allied form), table 10.
" [5]¹	..	?+	" 71 (apart from tardy liquefaction very like B. coli), table 10.
" [6]¹	..	-	" 73 (no kinship to B. coli), table 10.
" [7]¹	..	?+	" 78 (some kinship to B. coli), table 10.
" [8]¹	..	-	No sub-cultures made; no colonies like B. coli.

* In the case of this sample a positive result was obtained with 1 cc. of the water. (*See* next table.)

From the above table it will be seen that, when as much as 10 cc. of the water was subjected to the phenol gelatine test, exactly one-half of the samples examined yielded coli-like microbes. Some of the microbes isolated were quite typical of B. coli, others failed in one or more respects.

A water containing B. coli in 0·1 cc. may with reason be condemned, but when the quantity involved is 10 cc. the question may, perhaps, be a debatable one. Strictly speaking, no potable water should contain, even in 100 cc. or more, any microbe which can reasonably be considered as being of recent intestinal outcome. But there is great difficulty in coming to any definite conclusion regarding the past history of the coli-like microbes met with in water and soil cultivations; moreover, the variability of the organisms belonging to the coli group is so great that it is a difficult task to determine whether a particular micro-organism should or should not be classed as B. coli. B. coli, as compared with its sparse distribution in waters and soils, is so peculiarly abundant in sewage that it seems both unwise and unnecessary to push this valuable test too far. Perhaps a moderate view of the question would be to regard samples P^1, R^1, T^1, U^1, W^1, Y^1, $[2]^1$, $[4]^1$, $[5]^1$, $[7]^1$, as suspicious, and samples O^1, Q^1, V^1, X^1, Z^1, $[1]^1$, $[3]^1$, $[6]^1$, $[8]^1$, as showing no evidence of impurity on the basis of the B. coli test when 10 cc. of the water was submitted thereto. Sample S^1 contained many liquefying colonies, and although the microbe isolated from the 10 cc. culture did not prove to be B. coli, a positive result was obtained with the 0·1 cc. of the sample culture as shown in a previous table.

(c.) *Presence or absence of B. coli in* 1 *cc.*. Primary broth *cultures and subsequent* gelatine plating method. The results are shown in Table 7.

TABLE 7.

Showing as regards presence or absence of B. coli (or allied forms) in 1 cc., the results of the bacteriological examination of 20 samples of Chichester well water obtained from 20 different sources.

[Primary broth and subsequent plating method.]

Sample O¹	–	No sub-cultures made; no colonies like B. coli.
" P¹	–	" " "
" Q¹	–	" " "
" R¹	–	" " "
" S¹	+	*See* Microbe 20 (B. coli or allied form), table 10.
" T¹	+	" 25 (B. coli or allied form), table 10.
" U¹	+	" 31 (B. coli or allied form), table 10.
" V¹	–	No sub-cultures made; no colonies like B. coli.
" *W¹	–	" " " "
" X¹	+	*See* Microbe 42 (B. coli or allied form), table 10.
" Y¹	?+	" 47 (some kinship to B. coli), table 10.
" Z¹	–	" 50 (no kinship to B. coli), table 10.
" [1]¹ ..	–	No sub-cultures made; no colonies like B. coli).
" [2]¹ ..	+	*See* Microbe 58 (B. coli or allied form), table 10.
" [3]¹ ..	+	" 64 (B. coli or allied form), table 10.
" [4]¹ ..	+	" 67 (B. coli or allied form), table 10.
" [5]¹ ..	–	" 74 (no kinship to B. coli), table 10.
" [6]¹ ..	–	No sub-cultures made, no colonies like B. coli.
" [7]¹ ..	–	" " " "
" [8]¹ ..	–	" " " "

* In the case of this sample, B. coli was found in 0·1 cc. of the water (*see* table dealing with 0·1 cc. cultures).

From the above table it appears that eight out of the twenty samples contained B. coli (or allied forms) in 1 cc. As regards sample W¹, although no B. coli were found in the 1 cc. culture, this microbe was found in the 0·1 cc. cultivation. It may therefore be said that nearly half of the samples were open to suspicion of danger from animal contamination. Most bacteriologists would without hesitation condemn a water containing any B. coli in 1 cc. of the sample.

(d.) *Presence or absence of B. coli in* 10 *cc. Primary broth cultures and subsequent gelatine plating method.* The results are shown in Table 8.

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TABLE 8.

Showing as regards presence or absence of B. coli (or allied forms) in 10 cc.*, the results of the bacteriological examination of 20 samples of Chichester well water obtained from 20 different sources.

[Primary broth and subsequent plating method.]

Sample O^1	-	No sub-cultures made ; no colonies like B. coli.
„ †P^1	-	„ „ „ „
„ Q^1	+	*See* Microbe 11 (B. coli or closely allied form), table 10.
„ R^1	+	„ 15 (B. coli or closely allied form), table 10.
„ S^1	+	„ 21 (B. coli or allied form), table 10.
„ T^1	+	„ 26 (B. coli or allied form), table 10.
„ U^1	+	„ 32 (B. coli or allied form), table 10.
„ V^1	+	„ 34 (B. coli or allied form), table 10.
„ W^1	?+	„ 40 (? some kinship to B. coli), table 10.
„ X^1	+	„ 43 (B. coli or closely allied form), table 10.
„ Y^1	+	„ 48 (B. coli or closely allied form), table 10.
„ Z^1	+	„ 51 (B. coli or closely allied form), table 10.
„ $[1]^1$ ..	-	No sub-cultures made ; no colonies like B. coli.
„ $[2]^1$ ..	+	*See* Microbe 59 (B. coli or allied form), table 10.
„ $[3]^1$ ..	+	„ 65 (B. coli or allied form), table 10.
„ $[4]^1$ ..	+	„ 68 (B. coli or closely allied form), table 10.
„ $[5]^1$ ..	+	„ 75 (B. coli or allied form), table 10.
„ $[6]^1$ ..	-	„ 77 (B. coli or allied form), table 10.
„ $[7]^1$ ..	?+	„ 79 (B. coli or allied form), table 10.
„ $[8]^1$ ..	-	No sub-cultures made ; no colonies like B. coli.

* 0·1 cc. of a 10 cc. "filter brushing" of 1,000 cc. of the original water. Pasteur "filter brushing" method.

† In this sample a coli-like microbe was found in the 10 cc. gelatine plates.

It will be noted that fifteen out of twenty samples yielded coli-like microbes in 10 cc. (primary broth, and subsequent plating method).

(e.) *Presence or absence of B. coli in 100 cc. Primary broth cultures and subsequent gelatine plating method.* The results are shown in Table 9.

TABLE 9.

Showing as regards presence or absence of B. coli (or allied forms) in 100 cc.* the results of the bacteriological examination of 20 samples of Chichester well water obtained from 20 different sources.

[Primary broth and subsequent plating method.]

Sample O[1]	–	No sub-cultures made; no colonies like B. coli.
" P[1]	+	*See* Microbes 5, 6, 7, 8 (B. coli or allied forms), table 10.
" Q[1]	+	*See* Microbe 12 (B. coli or closely allied form), table 10.
" R[1]	+	" 16 (B. coli or closely allied form), table 10.
" S[1]	+	" 22 (B. coli or allied form), table 10.
" T[1]	+	" 27 (B. coli or closely allied form), table 10.
" U[1]	+	" 33 (B. coli or allied form), table 10.
" V[1]	+	" 35 (B. coli or allied form), table 10.
" W[1]	?+	" 41 (? some kinship to B. coli), table 10.
" X[1]	+	" 44 (B. coli or closely allied form), table 10.
" Y[1]	+	" 49 (B. coli or allied form), table 10.
" Z[1]	+	" 53 (B. coli or allied form), table 10.
" [1][1] ..	+	" 57 (B. coli or allied form), table 10.
" [2][1] ..	+	" 60 (B. coli or allied form), table 10.
" [3][1] ..	+	" 66 (B. coli or allied form), table 10.
" [4][1] ..	+	" 69 (B. coli or closely allied form), table 10
" [5][1] ..	+	" 76 (B. coli or allied form), table 10.
" [6][1] ..	–	No sub-cultures made, no colonies like B. coli.
" [7][1] ..	+	*See* Microbe 80 (B. coli or allied form), table 10.
" [8][1] ..	?+	" 81 (B. coli or allied form), table 10.

* 1·0 cc. of a 10 cc. "filter brushing" of 1,000 cc. of the original water. (Pasteur filter brushing method.)

From the above table it appears that no less than eighteen out of twenty samples contained B. coli (or allied forms) in 100 cc. of the water.

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How far it is justifiable to condemn a water containing coli-like microbes in 100 cc. when these micro-organisms are absent from 10 cc., is a moot point. It may, at all events, be safely said that samples O[1] and [6][1] were conspicuous as regards their purity, and that samples [1][1] and [8][1] (which contained coli-like microbes in 100 cc. but not in 10 cc.) were not wholly free from microbes seemingly of intestinal origin, and could not therefore be regarded as entirely unobjectionable in character.

Each case must doubtless be judged on its own merits, and in relation to the local conditions. For example, the presence in sparse amount in a "drinking-water stream" during floods of B. coli derived from the "washings" of cultivated soils along its banks, might be objectionable, but not so objectionable as a similar number of B. coli in a well water in the neighbourhood of defective sewers, and if there were reason to surmise that the presence of B. coli in such water bore no distant relation to recent pollution of the soil with the excremental matters of human beings.

Fixed bacteriological standards to apply to all kinds of water supply are always open to objection, but if they are adopted, and if they are meant to be rigidly adhered to, they must needs be moderate in character. Speaking from my own experience I should be inclined not to lay too much stress on the presence of B. coli in 100 cc. if it was absent from 10 cc. of the water sample; to regard with suspicion a water containing B. coli in 10 cc. but not in 1 cc.; and to condemn a water containing B. coli in 1 cc., even if this microbe were absent from 0·1 cc. But much would depend on a knowledge of the source of the supply, and also on the other results of the bacteriological analysis. To draw an arbitrary distinction between 10 cc. and 20 cc.; between 30 cc. and 40 cc. and so forth is unwarrantable.

(f.) *Differentiation from B. typhosus of the coli-like microbes isolated from the various samples of well water.*—In the following table (Table 10) an account is given in detail of the results of subculture of the various coli-like microbes met with during the course of the investigation. Theories and suppositions are apt to be open to criticism, and the hypotheses of the present may prove untenable in the future. But an honest and detailed statement of observed facts is of more than passing interest and may remain of value long after the inferences here accompanying it have been forgotten.

TABLE No. 10.

TABLE

No. of Microbe.	Well Water.	Source.					Motility.	Morphology (coli-like on the whole).	"Gas" in gelatine shake cultures, 24 hours at 20° C.	Diffuse cloudiness in broth cultures, 24 hours at 37° C.
		Amount of water in cc.								
		S. phen. gel. plate cultures.		Primary broth and secondary gel. pl. cult.						
		·1	10	1	10	100				
1	P¹		+							
2	"		+						-	+ feeble.
3	"		+				+	+	+	+
4	"		+				+	+	+ feeble.	+
5	"					+	+	+	+	+
6	"					+	+	+	+	+
7	"					+	+	+	+	+
8	"					+	+	+	+	+
9	Q¹		+				+	?+	-	+
10	"		+				-	?+	-	?+
11	"				+		+	?+	+	+
12	"					+	+	+	+	+
13	R¹		+				+	+	+	+
14	"		+				?-	+	-	+ feeble.
15	"				+		+	+	+	+
16	"					+	+	+	+	+
17	S¹	+							-	+ feeble.
18	"	+					+	+	+	+
19	"		+						-	+ feeble.
20	"			+			+	+	+	+
21	"				+		+	+	+	+
22	"					+	+	+	+	+
23	T¹		+				+	+	+	+
24	"		+				+	+	+	+
25	"			+			+	+	+	+
26	"				+		+	+	+	+
27	"					+	+	+	+	+
28	U¹	+					+	+	+	+
29	"		+				+	+	+	+
30	"	+							-	
31	"			+			+	+	+	+
32	"				+		+	+	+	+
33	"					+	+	+	+	+
34	V¹				+		?-	+	+	+
35	"					+	?-	+	+	+
36	W¹	+					+	+	+	+
37	"		+				+	+	+	+
38	X¹	+					?-	+	-	?+
39	"		+						-	?+
40	W¹				+		+	+	+	?+ pellicle.

10.

Indol in broth cultures, 5 days at 37° C.	Litmus milk cultures, 5 days at 37° C. Acidity.	Litmus milk cultures, 5 days at 37° C. Clot.	Liquefaction of gelatine, 30 days.	Neutral red broth test, greenish-yellow fluorescence, 24 hours at 37° C.	Serum test: unless otherwise stated the serum of a typhoid immunised guinea-pig was used. (1:50 dilution, 1 hour.)	Remarks.
-	?+ slight.	-	+ slow.	-		[1. No growth occurred in the original subculture.]
-	+	-	-	+	?-	
-	+ slight.	-	-	-	-	[3. Impossible to get emulsion free from clumps. On the whole, negative.]
-	+	-	-	+	?-	
-	+	-	-	+	-	
-	+	-	-	+	?-	[6. Same remarks as 3.]
-	+	-	-	+	-	
-	Alkali	-	-	-	-	[7. Same remarks as 3.]
-	Bleached look.	-	+ slow.	-	-	
-	+	+	-	+	?+	[11. ? Slight but incomplete clumping.]
+	+	+	-	+	-	
-	+	-	-	-	-	
-	?+ trace.	-	-	-	-	[14. Bore no morphological resemblance to B. typhosus and grew only feebly at blood heat.]
+	+	+	-	+	-	
+	+	+	-	+	-	
-	+ slight.	-	+ slow.	-		
-	+	+	-	+	-	
-	+ feeble.	-	+ slow.	-		
-	+	-	-	+	-	
-	+	-	-	+	-	
-	+	-	-	+	-	
+	+	+	-	+	-	
+	+	+	-	+	-	
+	Alkali	-	-	+	-	
-	+	-	-	+	?-	[26. Same remarks as 3.]
+	+	+	-	+	-	
-	+	+	-	+	-	[29. Same remarks as 3.]
-	+	-	-	+	?-	
						[30. No growth in milk and broth at 37° C.]
-	+	+	-	+	-	
-	+	+	-	+	-	
-	+	-	-	?+	-	[36. Clumping, almost instantaneous, 1:20; definite clumping, 1:50 in less than half an hour; 1:100 fair clumping in one hour, 1:200 slight clumping in one hour. Tried also with human typhoid blood serum (one case), 1:20 dilution, good clumping within a few minutes.]
-	+	+ weak.	-	?+	-	
-	+	-	-	?+	-	
-	+	+	-	+	+	
-	+	-	-	-	-	
-	Bleached look.	-	-	-	-	
-	Bleached look.	-	+ slow.	-		
-	+	+ ? peptonisation.	-	-	-	

TABLE 10—

No. of Microbe.	Source.						Motility.	Morphology (coli-like on the whole).	"Gas" in gelatine shake cultures, 24 hours at 20° C.	Diffuse cloudiness in broth cultures, 24 hours at 37° C.
	Well Water.	Amount of water in cc.								
		S. phen. gel. plate cultures.		Primary broth and secondary gel. pl. cult.						
		·1	10	1	10	100				
41	W1					+	+	+	+	?+ pellicle.
42	X^1			+			?-	+	+	+
43	,,				+		+	+	+	+
44	,,					+	+	+	+	+
45	Y^1	+					+	+	-	+ feeble.
46	,,		+				+	+	+	+
47	,,			+			+	+	+	+
48	,,				+		+	+	+	+
49	,,					+	+	+	+	+
50	Z^1	-		+			+	+	-	+
51	,,				+		+	+	+	+
52	,,					+	+	+	+	+
53	$[1]^1$	+					?-	+	-	?+ scum.
54	,,		+						-	?+ atypical.
55	$[2]^1$	+							-	
56	,,		+				+	+	+	+
57	$[1]^1$			+			?-	+	+	+
58	$[2]^1$			+			+	+	+	+
59	,,				+		+	+	+	+
60	,,					+	+	+	+	+
61	$[4]^1$	+					+	+	+	+
62	$[3]^1$		+				?-	-	-	-
63	$[4]^1$		+				+	+	+	+
64	$[3]^1$			+			+	+	+	+
65	,,				+		+	+	+	+
66	,,					+	+	+	+	+
67	$[4]^1$			+			+	+	+	+
68	,,				+		+	+	+	+
69	,,					+	+	+	+	+
70	$[5]^1$	+					?-	?-	-	- granular.
71	,,		+						-	+
72	$[6]^1$	+					?-	+	-	+
73	,,		+						-	feeble.
74	$[5]^1$			+			?-	+	-	- granular.
75	,,				+		+	+	+	+
76	,,					+	+	+	+	+
77	$[6]^1$				+		?-	+	-	- granular.
78	$[7]^1$		+				?-	+	+	+
79	,,				+		+	+	+	+
80	,,					+	+	+	+	+
81	$[8]^1$					+	+	+	+	+

continued.

Indol in broth cultures, 5 days at 37° C.	Litmus milk cultures, 5 days at 37° C.		Liquefaction of gelatine, 30 days.	Neutral red broth test, greenish-yellow fluorescence, 24 hours at 37° C.	Serum test: unless otherwise stated the serum of a typhoid immunised guinea-pig was used. (1:30 dilution, 1 hour.)	Remarks.
	Acidity.	Clot.				
-	+	+ ? peptonisation.	-	-	-	
-	+	-	-	+	-	
+	+	+	-	+	-	
+	+	+	-	+	-	
-	?+ trace.	-	-	-	-	[45. Quite unlike B. typhosus morphologically.]
-	+	-	-	-	-	
-	+	-	-	-	-	
+	+	+	-	+	-	[50. Morphologically unlike B. typhosus, acidity in milk culture pronounced, and negative result, Widal's test.]
+	+	+	-	+	-	
-	+	-	-	-	-	
+	+	-	-	+	-	
+	+	+	-	?+	-	
-	-	-	-	-	-	[53. Quite unlike B. typhosus morphologically and in broth culture.]
-	+ feeble.	-	+ slow.	-		
			+ slow.			[55. No growth in milk and broth at 37° C.]
-	+ slight.	-	-	+	-	
-	+	-	-	+	-	
-	+	-	-	+	-	
-	+	-	-	+	-	
-	+	-	-	+	-	[62. Morphologically quite unlike B. coli or B. typhosus. Granular cloudiness in broth and pellicle. Impossible to get emulsion free from clumps.]
-	+	-	-	-	-	
-	+ feeble.	-	-	-	?-	
-	+	-	-	-	-	
-	+	+	-	+	-	
-	+	-	-	+	-	[70. Morphologically and in other respects quite unlike B. typhosus. Impossible to get emulsion free from clumps.]
-	+	+	-	+	-	
+	+	+	-	+	-	
+	+	+	-	+	-	
+	+	+	-	+	-	
-	Bleached.	-	-	-	?-	
+	+	-	+ slow.	+	-	[72. Quite unlike B. typhosus, morphologically and in other respects.]
-	Bleached.	-	-	-	-	
			+ slow.			[73. No growth in milk and broth at 37° C.]
-	Bleached.	-	-	-	-	[74. Morphologically and in other respects quite unlike B. typhosus.]
-	+	-	-	+	?-	
-	+	+	-	+	-	
-	Bleached.	-	-	-	-	[75. Impossible to get emulsion free from clumps.]
-	+	+	-	-	-	
-	+	+	-	-	-	[77. Morphologically and in other respects quite unlike B. typhosus.]
-	+	-	-	+	-	
-	+	+	-	+	-	

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The foregoing table (10) includes the study of 81 microbes isolated from the different waters which could not on preliminary observation in the plate cultures be *definitely* said not to be B. typhosus. In most cases these microbes, as might be expected, proved to be B. coli (or allied forms). In some cases the microbes showed little or no resemblance to B. coli on further study, but in no instance was any serious difficulty encountered in differentiating any of them from B. typhosus.

In summary of these results the following points as regards the 81 micro-organisms in question seem worthy of note:—

Non-liquefying gas-forming coli-like microbes. — Fifty-nine examples were dealt with, and with result as follows:—

List.	59 microbes.	"Gas" in gelatine "shake" cultures.	Acidity in litmus milk cultures.	Acid clot, litmus milk cultures.	Indol in broth cultures.	Greenish yellow fluorescence in neutral red broth cultures.
1	13 = (22 %). [? 14 = 23 %].	+	+	+	+	+
2	10 = 17 %. [? 11 = 18 %].	+	+	+	—	+
3	1 = 1·7 %.	+	+	+	+	?+
4	19 = 32 %. [? 21 = 35 %].	+	+	—	—	+
5	7 = 12 %.	+	+	—	—	—
6	1 = 1·7 %.	+	alkali.	—	+	+
7	2 = 3·4 %.	+	+	+ ? peptonisation.	—	—
8	2 = 3·4 %.	+	+	+	—	—

Last year the neutral red broth test was not employed; but, excluding this test, and therefore legitimately adding together lists 4 and 5, this year's work compares somewhat closely with that of last year, as is shewn below:—

List.	1900–1.	1901–2.	33 consecutive samples of sewage. B. coli present in ·00001 cc.
1	20 %.	22 %.	78 %.
2	18 %.	17 %.	9 %.
4 and 5.	54 %.	44 %.	9 %.

It must be admitted that a much larger number of these gas-forming coli-like microbes failed as regards one or more positive tests than is found to be the case in sewage, and, more particularly, in normal stools. One inference from this is that, I was dealing in part with water microbes simulating, but not in reality related to the coli of excremental origin. This may be true to some extent, but there is another interpretation of the observed facts which, if suppositional, is not devoid of an element of probability, namely, that microbes of intestinal origin were being studied; which, severed from the animal host and forced to live under saprophytic conditions, had lost, or had maintained in diminished degree, some of their positive characters. It must be remembered, however, that the sub-cultures were made for a *two-fold* purpose, namely, search for the possible presence of B. typhosus as well as for the demonstration of excremental pollution. This means, of course, that certain microbes were sub-cultured not so much because of their *certain* resemblance to B. coli as because on preliminary observation they could not be *definitely* said not to be B. typhosus. The important point to note is that the presence of objectionable pollution should not be judged solely either by the numerical abundance of coli-like microbes or by the degree of reponse of these bacteria to arbitrary tests but by both these considerations taken in conjunction. By this method more trustworthy conclusions may be arrived at.

Non-gas-producing coli-like (on preliminary observation) microbes which eventually liquefied gelatine.—Of these there were nine examples. None of these, of course, could be regarded as showing any close kinship to B. coli. They naturally bore no relation at all to B. typhosus.

Non-gas-producing coli-like (on preliminary observation) microbes which were not observed to be liquefiers.—Twelve examples. One failed to grow in broth cultures at blood heat. One produced alkali in litmus-milk cultures. Five gave rise to a bleached appearance in litmus-milk cultures, and the remaining five were all unlike B. typhosus morphologically, and in other respects were capable of being differentiated without any real difficulty from this pathogenic microbe.

*Agglutination test.**—All those microbes which bore any reasonable resemblance either to B. coli or B. typhosus were tested with the serum of a typhoid immunised guinea-pig. The time limit was one hour, and the dilution 1 : 20. Some may consider that a dilution of 1 : 50 or 1 : 100 or even 1 : 1,000 should have been used. But, as nearly all my results were negative when using a dilution of 1 : 20, this objection is seemingly nullified. By using too great a dilution, there is risk of failing to draw any distinction between the few coli-like microbes which unquestionably respond to the agglutination test, and the large number which yield an absolutely negative result. Yet this

* Dr. Horrocks working with anti-typhoid serum (typhoid immunised horse) of high agglutinating power (B. typhosus, 1 in 10,000 dilution partial clumping; 1 in 1,000 complete clumping) obtained some very striking results in the course of his prolonged and able investigations. He tested 70 samples of B. coli derived from healthy stools, and 80 from typhoid stools, with a 1 : 50 dilution of the anti-typhoid serum. 11·5 per cent. of the former, and no less than 52·5 per cent. of the latter, gave a strongly positive result (complete agglutination).

distinction may be of considerable importance. Nevertheless, I am in close agreement with those who assert that to prove the true nature of a suspected typhoid microbe, high dilutions of the serum of typhoid immunised animals should be used. Unfortunately, none of my microbes bore so close a resemblence to B. typhosus as to render this precaution necessary. Recent (24–48, but nearly always 24 hours) gelatine cultures (oblique) were used, and the emulsion was made in broth. Although the great majority of coli-like microbes formed a homogeneous emulsion, this was not always found to be the case. Indeed, with some it was quite impossible to obtain an emulsion free from clumps of bacilli. In these cases, it was only possible to arrive at a diagnosis by close comparison with a control experiment, and I have entered these cases in the table as negative with a query.

Of the 71 microbes of experiment, no fewer than 61 gave a wholly negative result.* Eight microbes yielded a result which has been entered in the table as negative with a query, because it was impossible in these cases to prepare the original emulsion free from clumps. In comparison with a control in each case, none of these bacilli showed any perceptible increase of clumping after the addition of the blood of the typhoid immunised animal. One microbe (11) gave a very doubtfully positive result, and this has been entered in the table as positive with a query. The remaining microbe (36) gave a strong positive result, both with human typhoid blood serum, and the serum of a typhoid immunised guinea-pig.

A guinea-pig was immunised with microbe 36, and the blood of this animal was repeatedly tested against the same strain of B. typhosus which had been used to immunise the typhoid immunised guinea-pig, whose blood was so active in clumping microbe 36. The results were wholly negative, that is, there was no "cross clumping." Even at a stage when the blood of the "36 coli-microbe immunised guinea-pig" clumped "36 coli-microbe" in a dilution of 1 : 200, it failed to clump B. typhosus in a dilution of 1 : 20 (one hour). It is difficult to comprehend why the blood of a typhoid immunised animal should clump an "X coli-microbe" when the blood of an "X coli-microbe immunised animal" fails to clump the same strain of B. typhosus which was used to immunise the original animal. But it will be remembered that a precisely similar result was obtained in last year's work with microbe 44.

The biological characters of this coli-microbe (36) were not such as to allow of its being included in the *Gärtner* group. Thus, it gave gas in gelatine shake cultures, produced acid clotting in litmus-milk cultures, and gave a strong positive result with the neutral red broth test; and, moreover, its growth in gelatine and agar media was in every respect like B. coli. It was highly motile

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* This is not perhaps strictly true, because a number of the microbes showed a "tendency to clump" or a "suspicion of clumping." This appearance was always recorded a negative, because a really positive result, when it occurs, is so striking and unmistakeable that to drag in extremely doubtful cases is apt to lead to much confusion. It should also be added that I am not prepared to deny that a greater number of positive results might possibly have been obtained if a serum of still higher agglutinating power than that used by me had been available.

and morphologically was indistinguishable from B. coli. Only as regards indol formation did it give a negative result. Last year a similar result was obtained, namely, that the few microbes which responded to the agglutination test were not atypical of B. coli, but rather the reverse.

App. B, No. 7.
On the Chemical and Bacteriological Examination of Chichester Well Water; by Dr. Houston.

The analysis of the 231 coli-like microbes isolated from the well waters during this year and last year's work will, I trust, be of general value in connection with the bacteriology of water supply apart from its special bearing on the Chichester inquiry.*

(4.) *Spores of B. enteritidis sporogenes* (Klein).—The results are shown in Table 11.

TABLE 11.

Description of the Samples of Water.		Spores of B. enteritidis sporogenes (Klein) in :—		
		10 cc.†	100 cc.†	200 cc.†
N.F. Sample O[1], 2, Stirling Road ..	September 30th, 1901	-	-	-
F. Sample P[1] 120, St. Pancras ..	September 30th, 1901	-	-	-
F. Sample Q[1], 27, Chapel Street ..	October 7th, 1901 ..	-	-	-
N.F. Sample R[1], 7, 8, 9, Chapel Street	October 7th, 1901 ..	-	-	-
F. Sample S[1], 52, Victoria Road ..	October 14th, 1901 ..	-	-	-
N.F. Sample T[1], Cattle Market ..	October 14th, 1901 ..	-	-	-
F. Sample U[1], 16, St. Pancras ..	October 21st, 1901 ..	-	-	-
N.F. Sample V[1], 39, Bognor Road ..	October 21st, 1901 ..	-	-	-
F. Sample W[1], 2, North Gate ..	October 28th, 1901 ..	-	? +	? +‡
N.F. Sample X[1], 1, 2, 3, Basin Cottages	October 28th, 1901 ..	-	-	? +§
F. Sample Y[1], 32, Orchard Terrace	November 4th, 1901..	-	-	-
N.F. Sample Z[1], 2, South Gate ..	November 4th, 1901..	-	-	-
F. Sample [1][1], 18, Washington St.	November 11th, 1901	-	-	-
N.F. Sample [2][1], Cottage in Orchard Park	November 11th, 1901	-	-	-

† Pasteur "filter brushing" method.

‡ 1¼ cc. of the culture was inoculated into a guinea-pig. The animal died, but not until the sixth day (? B. enteritidis sporogenes).

§ 1 cc. of the culture was inoculated into a guinea-pig. The animal died, but not until the third day (? B. enteritidis sporogenes).

F = reputed fever area.

N.F. = reputed non-fever area.

* An experiment which yielded negative results may be here recorded. An attempt was made to immunise a guinea-pig with repeated small doses of sewage with the object of testing its blood against microbes isolated from the Chichester well waters and suspected to be of animal outcome. But the blood of the guinea-pig tested against strains of B. proteus, B. fluorescens liquefaciens, and B. coli *isolated* from *sewage itself* yielded practically negative results, and the attempt to push the immunisation process led to the death of the animal.

TABLE 11—*continued.*

Description of the Samples of Water.		Spores of B. enteritidis sporogenes (Klein) in :—		
		10 cc.*	100 cc.*	200 cc.*
F. Sample [3][1], Mill House, St. Paul's Road.	November 18th, 1901	-	-	-
N.F. Sample [4][1], 10, North Gate ..	November 18th, 1901	-	-	-
F. Sample [5][1], 13, Washington St.	November 25th, 1901	-	+†	+†
N.F. Sample [6][1], 2, Oaklands Cottage.	November 25th, 1901	-	-	-
F. Sample [7][1], 1, Cavendish St.	December 2nd, 1901..	-	-	-
N.F. Sample [8][1], Blacksmith's Shop, North Gate.	December 2nd, 1901..	-	-	-

* Pasteur "filter brushing" method.
† 1 cc. of the culture in each case killed a guinea-pig in less than 24 hours.
F.=reputed fever area.
N.F.=reputed non-fever area.

Of these twenty samples of water, none yielded a positive result with 10 cc. One yielded a doubtfully positive result with 200 cc., but a negative result with 100 cc. One sample yielded a doubtfully positive result with 100 cc., and a negative with 10 cc. Lastly, one sample, although giving a negative result with 10 cc., gave an undeniably positive result with 100 cc. It will thus be seen that the samples were remarkably free from the spores of this pathogenic anaërobe. It is not improbable that these results may be due to the spores in a greater degree than the bacilli tending to become associated with particles of organic matter, and thus to cling to the sides or sink to the foot of the well. Possibly also spores to a greater extent than bacilli are liable to be held back in soil infiltrated with sewage. As regards the conclusions to be drawn from these results it will, I think, be not out of place if I quote from last year's report as follows :—

"Notwithstanding the undoubted value of this test in the bacterioscopic analysis of water, I am inclined to think that a nice judgment is sometimes required in interpreting results. For example, in the presence of much suspended matter, and in the absence of other bacteriological data pointing to recent animal pollution, some caution should be exercised before condemning a water on account of the mere presence of B. enteritidis sporogenes. Flood water is a case in point because it contains much suspended matter, which is objectionable or is relatively harmless according to its derivation. Such water may be judged of by other bacteriological tests, tests capable of yielding evidence of recent and, therefore, specially dangerous contamination. But in the absence (relatively speaking) of suspended matter and in the presence of bacteria seemingly of objectionable sort, the concomitant presence of B. enteritidis sporogenes, even in sparse amount, is apt to be specially significant. Nor can its absence even from a large bulk of water in these cases be considered conclusive proof of harmlessness of the water. Where the line should be drawn involves the question of standards and although I have had some experience of the bacteriological examination of soils, waters, and sewage, I hesitate to touch on this matter. This much may be said without any danger of raising points open to controversy. The spores of B. enteritidis sporogenes are present in $\frac{1}{100}$ cc. to $\frac{1}{1000}$ cc. of sewage. In virgin soils this microbe has a sparse distribution, but in

polluted and cultivated soils it is present in great abundance (1,000 to 10,000 per gramme). Pure waters may contain no spores even in 100–500 cc. or more of the sample. Speaking in general terms, a reasonable view would seem to be this: a potable water should be condemned if it contains B. enteritidis sporogenes in 10 cc., and regarded with suspicion* if this microbe is present in 100 cc. Absence of B. enteritidis sporogenes from 100 cc. implies *relative* safety, but absence from even 200 cc. need not necessarily in all cases be accepted as indicating absolute freedom from danger of a potential if not actual kind."

(5.) *Streptococci.*—The results are shown in Table 12.

TABLE 12.

Description of the Samples of Water.		Presence (+) or absence (−) of streptococci in 10 cc. (0·1 cc. of a 10 cc. "filter brushing" of 1,000 cc.). Agar plate cultures at 37°C.
N.F. Sample O¹, 2, Stirling Road	September 30th, 1901 ..	-
F. Sample P¹, 120, St. Pancras..	September 30th, 1901 ..	-
F. Sample Q¹, 27, Chapel Street	October 7th, 1901	-
N.F. Sample R¹, 7, 8, 9, Chapel St.	October 7th 1901	-
F. Sample S¹, 52, Victoria Road	October 14th, 1901	-
N.F. Sample T¹, Cattle Market ..	October 14th, 1901	? +
F. Sample U¹, 16, St. Pancras .	October 21st, 1901	? -
N F. Sample V¹, 39, Bognor Road	October 21st, 1901	-
F. Sample W¹, 2, North Gate ..	October 28th, 1901	-
N.F. Sample X¹, 1, 2, 3, Basin Cottages.	October 28th, 1901	-
F. Sample Y¹, 32, Orchard Terrace.	November 4th, 1901 ..	-
N.F. Sample Z¹, 2, South Gate ..	November 4th, 1901 ..	-
F. Sample [1]¹, 18, Washington Street.	November 11th, 1901 ..	-
N.F. Sample [2]¹, Cottage in Orchard Park	November 11th, 1901 ..	-
F. Sample [3]¹, Mill House, St. Paul's Road.	November 18th, 1901 ..	? -
N.F. Sample [4]¹, 10, North Gate	November 18th, 1901 ..	-
F. Sample [5]¹, 13, Washington Street.	November 25th, 1901 ..	-
N.F Sample [6]¹, 2, Oaklands Cottage.	November 25th, 1901 ..	-
F. Sample [7]¹, 1, Cavendish St.	December 2nd, 1901 ..	? -
N.F. Sample [8]¹, Blacksmith's Shop, North Gate.	December 2nd, 1901 ..	-

F. = reputed fever area.
N.F. = reputed non-fever area.

* Not perhaps always condemned if other bacteriological tests give no indication of recent fouling with animal matters.

From the foregoing table it will be seen that 10 cc. from sixteen separate samples yielded a wholly negative result, three samples a negative result with a query and one sample a questionably positive result. Thus practically all the waters failed to show evidence of *extremely recent* fouling with matters of intestinal outcome, as judged by this test. Last year the results were somewhat similar, but a positive result was obtained in five out of the thirty samples examined. Of course, negative results must be accepted with some reserve in connexion with this test; because it is always possible, even if great care is taken, to overlook streptococci in plate cultures, and also it is not unknown for a streptococcus colony occurring in the original plate culture to refuse to grow when subcultured in broth.

IV.—General Summary of the Chemical and Bacteriological Results obtained in this Investigation :—

Chemical results.

The majority of the samples contained only traces of free ammonia; but in two wells [1][1] and [5][1] both situated in the same street the amount was excessive, in another well [7][1] great, and in yet another [6][1] much above the average of the remaining wells. As regards albuminoid ammonia nearly all the samples were either very pure or came well within the limits of "permissible impurity," but sample 2[1] was open to some suspicion of danger and [1][1] and [5][1] could only be described as "dirty" waters on the basis of this test alone. None of the well waters could have been condemned on the results of the oxygen absorbed from permanganate test; on the contrary, all of them came under the category of water of "great organic purity." Most of the samples contained no more, if as much, chlorine as might be expected from ordinary well water. But in a few cases the amount was certainly suspicious. Thus samples [5][1], [2][1], [7][1], [1][1], [6][1], contained, respectively, 7·5, 5·8, 5·1, 4·5, and 4·3 parts of chlorine, and two of these [5][1] and [1][1] yielded also very high figures as regards free and albuminoid ammonia. A general comparison of the results obtained from the examination of the wells obtained from the "fever" and "non-fever" areas on corresponding dates, would seem to indicate that, on the whole, the former were slightly less pure than the latter, but not to any striking extent. That the specially impure samples [1][1] and [5][1] were from reputed fever areas may or may not be a coincidence.

Bacteriological results.

The bacteriological results stand out in marked contrast to the chemical results. Thus, nine out of the twenty samples would have been condemned while sixteen out of the twenty would have been regarded with suspicion, if not rejected, on the basis of the B. coli test alone.

In the following table (Table 13) the chief bacteriological results are grouped together :—

TABLE 13.

Sample.	Total number of bacteria in :—	Gas in gelatine shake cultures (24 hours at 20° C.)		Presence (+) or absence (−) of B. coli (or allied forms) in :—				Presence (+) or absence (−) of B. enteritidis sporogenes (Klein) in :—			Presence (+) or absence (−) of Streptococci in :—
	1 cc.	10 cc.	100 cc.	0·1 cc.	1 cc.	10 cc.	100 cc.	10 cc.	100 cc.	200 cc.	10 cc.
O^1 (N.F.)	1	−	−	−	−	−	−	−	−	−	−
P^1 (F.) ..	30	−	−	−	−	+	+	−	−	−	−
Q^1 (F.) ..	71	−	−	−	−	+	+	−	−	−	−
R^1 (N.F.)	296	−	−	−	−	+	+	−	−	−	−
S^1 (F.) ..	270	−	−	+	+	+	+	−	−	−	−
T^1 (N.F.)	140	−	−	−	+	+	+	−	−	−	? +
U^1 (F.) ..	160	−	−	+	+	+	+	−	−	−	? −
V^1 (N.F.)	10	−	−	−	−	+	+	−	−	−	−
W^1 (F.) ..	280	−	−	+	+	? +	? +	−	? +	? +	−
X^1 (N.F.)	1,080	−	−	−	+	+	+	−	−	? +	−
Y^1 (F.) ..	880	−	−	−	? +	+	+	−	−	−	−
Z^1 (N.F.)	3,440	−	−	−	−	+	+	−	−	−	−
[1]^1 (F.)	1,920	−	−	−	−	−	+	−	−	−	−
[2]^1 (N.F.)	2,400	−	−	−	+	+	+	−	−	−	−
[3]^1 (F.) ..	1,680	−	+	−	+	+	+	−	−	−	? −
4]^1 (N.F.)	1,340	−	+	? +	+	+	+	−	−	−	−
[5]^1 (F.) ..	264	−	−	−	−	+	+	−	+ virulent	+ virulent	−
[6]^1 (N.F.)	1,320	−	−	−	−	−	−	−	−	−	−
[7]^1 (F.) ..	60	−	−	−	−	? +	+	−	−	−	? −
[8]^1 (N.F.)	107	−	−	−	−	−	? +	−	−	−	−

F. = reputed fever area.
N F. = reputed non-fever area

APP. B, No. 7.

On the Chemical and Bacteriological Examination of Chichester Well Water; by Dr. Houston.

In the first place, it is to be noted that the total number of bacteria in a sample does not necessarily afford a safe criterion of its potential harmfulness. Thus, it is worth noting that samples S^1, U^1, W^1 contained only 270, 160, and 280 microbes respectively per cc.; yet B. coli was present in each one of them, and in so small an amount as 0·1 cc. Further, in samples P^1, Q^1, V^1, and $[7]^1$, all of which contained considerably less than 100 bacteria per cc., B. coli (or some organisms allied thereto) was present in 10 cc. in each case. On the other hand, samples Z^1, $[1]^1$, and $[6]^1$, contained as many as 3,440, 1,920, and 1,320 bacteria in 1 cc.; yet B. coli was seemingly absent from 1 cc. of Z^1, 10 cc. of $[1]^1$ and 100 cc. of $[6]^1$. Lastly, sample Z^1 although containing as many as 3,440 microbes per cc., contained no spores of B. enteritidis sporogenes in 200 cc., while sample $[5]^1$ containing only 264 bacteria in 1 cc. yet contained virulent spores of B. enteritidis sporogenes in 100 cc.

Secondly, adopting tentatively for the purpose of a summary of the results the view that the presence of B. coli in :—(1) 0·1 cc.; (2) in 1 cc. but not 0·1 cc.; (3) in 10 cc. but not 1 cc.; and (4) in 100 cc. but not 10 cc. of a sample, should be, respectively, interpreted as :—(1) certainly condemning it; (2) as still condemnatory; (3) as probably leading to its rejection; and (4) as possibly or probably a sign of the presence of minute traces of animal pollution; then the various samples may be classified as follows :—Four samples in the first list, five in the second, seven in the third, and two in the fourth.* Lastly, two samples O^1 and $[6]^1$ showed no evidence when subjected to the most searching investigation of the presence of microbes of intestinal sort.

Thirdly, it will be remembered that last year it was pointed out that, although none of the waters could have been condemned on the basis of the free ammonia, albuminoid ammonia, or oxygen absorbed from permanganate tests, the majority of them were open to suspicion, while a few of them were obviously polluted, as judged by a searching bacteriological investigation. This year a very similar state of things was found, but it is worth noting that the chemical results were not so uniformly good and that the two samples $[1]^1$ and $[5]^1$, pre-eminently bad on chemical grounds, were according to the B. coli test very far from being the worst of the series. Indeed, $[1]^1$ contained no B. coli in 10 cc., and $[5]^1$ none in 1 cc. It is not unlikely that as regards samples $[1]^1$ and $[5]^1$ a mechanical separation of the bacteria in polluted soil surrounding the wells was taking place, the soluble organic matter reaching the water supply in bulk without being accompanied by a corresponding increase in the number of bacteria. In cases of this kind and assuming my contentions to be correct, a chemical analysis may be of real value as likely to indicate *potential* danger provided the contamination is sufficiently great to respond to chemical tests. I say potential and not actual danger because

* In the above summary I have treated the few microbes marked positive with a query as completely positive.

as long as the bacteria are held back in the interstices of the soil the element of risk is practically non-existent. It is only when under some new set of conditions the bacteria as well as the soluble organic matter reach the water supply that danger ensues. And even then the danger may still remain potential in character if the specific microbes of disease are absent.

Fourthly, these well waters in general were found to be (as in last year's work) not remarkable so much as regards evidence of actual and unmistakeable harmfulness, as on account of certain inherent biological qualities which suggest their objectionable origin—qualities masked to a considerable extent by the effects of filtration of the water through the soil.

Fifthly, a general comparison of the results obtained from the examination of the wells from the fever and non-fever areas on corresponding dates, seems to show that as regards total number of bacteria, the latter were most open to suspicion, but that as regards the B. coli test the former showed greater signs of pollution. The difference was not, however, of a striking or uniform character.

Lastly, the failure to discover the typhoid bacillus in the well waters is to be regretted, although the matter is one of possibly secondary importance. The chance discovery of B. typhosus would, by itself, only have meant that a particular sample of water, at a given time, was *specifically* polluted. Such a fortuitous circumstance as the isolation of the enteric fever bacillus would not by itself implicate the Chichester well waters in general, and would not point to general pollution of the sub-soil water. The scope of the enquiry was a broader one than could be achieved by solely searching for B. typhosus, although this part of the research was by no means neglected. As has been already indicated it was sought to discover whether the well waters, in general, showed any signs of animal pollution, and thus not solely or chiefly to prove the presence of an element of danger to the drinkers of well water but rather to ascertain how far a searching investigation of the biological qualities of the sub-soil water would throw light on Dr. Thomson's tentative hypothesis that soil plays some part in "fostering and localising" enteric fever in Chichester. For, as was pointed out in last year's report, the well water is really the sub-soil water, and the sub-soil water is the "washings" of the soil more or less altered in character by passage through the soil. In this broad sense the results have not been inconclusive, and lend some support to Dr. Thomson's soil theory to which he was driven only after a judicial consideration of all the other agencies likely to explain the "continued prevalence of enteric fever in serious amount" in Chichester. Dr. Thomson, in his report, does not attempt the task of linking together the saprophytic and parasitic phases of B. typhosus, and as his conclusions are opposed to the well water supply being a fertile means of conveying the disease, I can only assume that he includes in his conceptions the

surface layers of soil. Excluding *surface* soil,* and in my opinion the balance of evidence is rather against the long persistence of B. typhosus in surface layers of soil, there is difficulty in understanding by what channel, other than through water supply, the infection could be conveyed to the individual from the deeper layers of soil. But these are matters which may be left to the epidemiologist, and the inferences legitimately to be drawn from my results are from my own point of view of secondary importance to fulfilling as faithfully as possible the practical objects of the research itself.†

Addendum A, at the end of the report, deals with the levels of the sub-soil water during 1901 and part of 1902. The position of the wells is shewn on the map by blue dots and letters.

Addendum B gives the rainfall at the sewage works.

Addendum C shows the houses invaded by enteric fever during 1901. Seventeen cases occurred during the year 1901, and at the time of writing this report (March, 1902), no further cases had been notified. The position of the houses attacked by enteric fever is indicated by red dots on the accompanying map, and on the same map the locality of the wells examined is shewn by black dots. From a consideration of the map there would not seem to be any topographical relation between the houses invaded by enteric fever during 1901 and the sites of the various wells examined, except as regards samples U^1 and P^1. A case of enteric fever occurred at 4, Alexandra Terrace, on September 30th, 1901. Sample U^1 from the well closely adjacent was examined on October 22nd, 1901, and was found chemically to be very pure. Bacteriologically tested it contained only 160 microbes per cc., but it contained B. coli in as small an amount of water as $\frac{1}{10}$ cc.

Another case of enteric fever was notified from 120, St. Pancras, on June 18th, 1901. Sample P^1 from the same house was examined some months later, viz., on September 30th, 1901. The chemical results indicated that it was a water of great purity. Bacteriologically examined it was found to contain only 30 microbes per cc.; but B. coli was present in 10 cc. of the water. But although during the period of survey there seemed to be no general topographical relation between the sites of the various

* The recent work, however, of Drs. Firth and Horrocks would seem to point to the persistence of B. typhosus in particular soils under certain conditions of experiment for a considerable period. Nevertheless no "soil theory" dissociated from water supply as a carrying medium of the virus can be accepted without misgivings as explanatory of the endemic and epidemic prevalence of typhoid fever at Chichester and elsewhere. Such "soil suppositions" would seem to depend not only on the prolonged viability of B. typhosus in soil but on an occasional exacerbation of its virulence and increase too in its relative abundance. In these doctrines there may be more than the mere germ of truth, but at present they are not in correspondence with the experience of most bacteriologists which points to the *relative* death of pathogenic microbes of non-sporing sort in the *surface* layers of soil and, by inference, to an accompanying loss of the morbific power of the survivors.

† Koch's recent work, in contra distinction to his earlier and classical researches, throws a shadow of doubt on water as an important means of spreading disease. Prolonged investigations alone can solve these problems, but it needs to be remembered that long before bacteriology was known it was deemed advisable to avoid drinking water contaminated with the alvine discharges of even the lower animals.

wells and the houses invaded by enteric fever, it is quite possible that a spot map covering a period of several years might show that around a number of these wells there had been a clustering of cases in greater proportion than elsewhere. This, however, is a matter which, if gone into at all, would need to be studied in a very thorough manner, and in relation to many factors other than water supply. And it does not seem desirable, in a report of this kind, to enter into questions, not intimately associated with the scientific aspects of the investigation.

PART II.

I. Results of a Special Examination of the Well Waters from the Reputed Fever Areas for the Presence of B. Typhosus.

During this part of the inquiry search was made for B. typhosus only; no chemical or other bacteriological investigations were attempted. Moreover, only the well waters from reputed fever areas were examined.

II. Description of the Method Adopted in this Part of the Investigation.

1,000 cc. of the water were filtered through a sterlised Pasteur filter, and a 5 cc. "filter brushing" made * From this 5 cc. "filter brushing" cultures were made as follows:—

(a.) *Surface gelatine plate culture method.*—A series of sterile plates, into each of which 10 cc. of sterile gelatine had been poured and allowed to solidify, were inoculated severally with 0·005, 0·01, 0·05, 0·1, and 0·25 of the 5 cc. filter brushing (representing approximately the bacterial contents of 1, 2, 10, 20, 50 cc. of the well water); and surface cultures were made in the usual way.

(b.) *Primary broth and secondary surface gelatine plate culture method.*—2 cc. of the 5 cc "filter brushing" (= 400 cc. of the water) were added to broth tubes, and after incubation at 37° C. for 24–48 hours, surface gelatine plate cultures made.

In each case, the colonies developing in the plates were subjected to attentive scrutiny, and those colonies bearing any reasonable resemblance (on preliminary observation) to B. typhosus were subcultured in gelatine "shake" cultures. As might have been anticipated these in the majority of cases gave gas. When this occurred the microbe in question was not further examined. But when no gas developed in gelatine "shake" cultures, no colour was formed, or no liquefaction occurred, then the following plan was usually adopted:—

Broth cultures were made and incubated at 37° C. for five days, and then tested for indol production. Sometimes no growth occurred at blood heat, and sometimes growth together with indol formation. In either case, of course, it was unnecessary further to investigate the microbes in question. But when growth occurred at 37° C. and no indol was produced, litmus milk cultures were made, and incubated at 37° C. B. typhosus in litmus-milk cultures forms *feeble* acid and never clots the milk. Whenever, therefore, any of the following changes occurred in the milk the culture was rejected—bleached or buff-coloured appearance, strong acid, clotting, alkaline change.

Practically in all cases, the above tests served to differentiate the suspected microbes from B. typhosus, but occasionally a microbe was tested as well by the serum test (blood of typhoid immunised guinea-pig).

These differential tests were not always employed in exactly the above order, and often were used concurrently; but the final result turned out always to be the same, namely, that no real difficulty was experienced in distinguishing the suspected microbes from B typhosus.

* In two cases a 10 cc. "filter brushing" was employed.

III. Analysis of the Microbes which on Preliminary Observation in the Plate Cultures could not, without further Study, be said not to be B. Typhosus.

The results are shewn in the following table (Table 14) :—

Table 14.

Description of microbe and its source.			"Gas" in gelatine "shake" cultures, 20° C.	Chromogenic. Y—Yellow. G—Green. V—Violet.	Liquefaction of gelatine, 20° C.	Broth cultures at 37° C. N.G.—No growth.	Indol in broth cultures, 37° C.	Litmus milk cultures, 37° C.	Remarks.
Microbe 1..	1 cc.	P*	+						P* was collected on December 11th. 1901.
„ 2..	„	„	-	+G					
„ 3..	„	„	-	-	-		-	Dirty bleached appearance, quite unlike B. typhosus.	
„ 4..	2 cc.	„	-	-	-	NG			
„ 5..	„	„	-	-	+				
„ 6..	„	„	-	-	+				
„ 7..	10 cc.	„	-	-	+				
„ 8..	„	„	-	-	+				
„ 9..	„	„	-	-	·	NG			
„ 10..	„	„	+						
„ 11..	„	„	+						
„ 12..	„	„	-	-	-		-	Strong acid, unlike B. typhosus.	
„ 13..	„	„	+						
„ 14..	„	„	-	+Y					
„ 15..	„	„	-	+Y					
„ 16..	20 cc.	„	-	-	-	NG			
„ 17..	„	„	-	-	+				
„ 18..	„	„	-	-	-		+		
„ 19..	„	„	-	-	-		-	Pale buff colour, quite unlike B. typhosus.	
„ 20..	„	„	-	-	+				
„ 21..	2 cc.	Q*	-	+Y					
„ 22..	„	„							Original subculture gave no growth.

TABLE 14—*continued.*

Description of microbe and its source.			"Gas" in gelatine "shake" cultures, 20° C.	Chromogenic. Y—Yellow. G—Green. V—Violet.	Liquefaction of gelatine, 20° C.	Broth cultures at 37° C. N.G.=No growth.	Indol in broth cultures, 37° C.	Litmus milk cultures, 37° C.	Remarks.
Microbe 23 ..	10 cc.	Q^a	-	-	+				
,, 24 ..	,,	,,	-	-	+				Q^a was collected on December 11th, 1901.
,, 25 ..	,,	,,	-	-	+				
,, 26 ..	,,	,,	-	+Y					
,, 27 ..	,,	,,	-	-	-		+		
,, 28 ..	20 cc.	,,	-	+Y					
,, 29 ..	,,	,,							Original sub-culture gave no growth
,, 30 ..	,,	,,	-	+Y					
,, 31 ..	,,	,,	+						
,, 32 ..	,,	,,	+						
,, 33 ..	,,	,,	-	+Y					
,, 34 ..	50 cc.	,,	-	-	-		+		
,, 35 ..	,,	,,	-	+Y					
,, 36 ..	,,	,,	-	+Y					
,, 37 ..	,,	,,	-	-	+				
,, 38 ..	400 cc.	P^a	+						
,, 39 ..	,,	,,	+						
,, 40 ..	,,	,,	+						
,, 41 ..	,,	,,	+						
,, 42 ..	,,	,,	+						
,, 43 ..	,,	Q^a	+						
,, 44 ..	,,	,,	+						
,, 45 ..	,,	,,	+						
,, 46 ..	,,	,,	+						
,, 47 ..	,,	,,	+						
,, 48 ..	,,	,,	+						
,, 49 ..	,,	,,	-	-	-		-	Pale buff colour.	
,, 50 ..	,,	,,	-	-	+				
,, 51 ..	·5 cc.	S^a	-	-	-		-	Dirty bleached look, quite unlike B. typhosus.	S^a was collected on December 18th, 1901.

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TABLE 14—*continued.*

Description of microbe and its source.			"Gas" in gelatine "shake" cultures, 20° C.	Chromogenic. Y—Yellow. G—Green. V—Violet.	Liquefaction of gelatine, 20° C.	Broth cultures at 37° C. N.G.—No growth.	Indol in broth cultures, 37° C.	Litmus milk cultures, 37° C.	Remarks.
Microbe 52 ..	·5 cc.	S²	+						
,, 53 ..	,,	,,	-	-	-		-	Dirty bleached look, quite unlike B. typhosus.	
,, 54 ..	,,	,,	+						
,, 55 ..	1 cc.	S²	-	-	-		-	Acid clot.	
,, 56 ..	,,	,,	-	-	-		-	Dirty bleached appearance, quite unlike B. typhosus.	
,, 57 ..	,,	,,	+						
58 ..	,,	,,	-	-	-		-	,, ,,	Morphologically unlike B. typhosus. Serum test negative.
,, 59 ..	,,	,,	+						
,, 60 ..	,,	,,	+						
,, 61 ..	,,	,,	+						
,, 62 ..	5 cc.	S²	-	-	-		-	Acid clot.	
,, 63 ..	,,	,,	+						
,, 64 ..	,,	,,	-	-	-		-	Bleached appearance.	,, ,,
,, 65 ..	,,	,,	-	-	-		-	Acid clot.	
,, 66 ..	,,	,,	-	-	+				
,, 67 ..	10 cc.	,,	-	-	-		-	Bleached look.	Do.
,, 68 ..	,,	,,	+						
,, 69 ..	,,	,,	+						
,, 70 ..	,,	,,	-	-	-		-	Dirty bleached appearance, quite unlike B. typhosus.	
,, 71 ..	·5 cc.	U²	+						U² was collected on December 18th, 1901.
,, 72 ..	1 cc.	,,	+						
,, 73 .	5 cc.	,,	+						
,, 74 ..	,,	,,	+						
,, 75 ..	,,	,,	+						
,, 76 ..	,,	,,	-	-	+				

TABLE 14—*continued.*

Description of microbe and its source.			"Gas" in gelatine "shake" cultures, 20° C.	Chromogenic. Y—Yellow. G—Green. V—Violet.	Liquefaction of gelatine, 20° C.	Broth cultures at 37° C. N.G.—No growth.	Indol in broth cultures, 37° C.	Litmus milk cultures, 37° C.	Remarks.
Microbe 77..	5 cc.	U²	-	+V					
" 78..	10 cc.	"	-	-	+				
" 79..	"	"	+						
" 80..	"	"	-	-	+				
" 81..	"	"	-	-	-		-	Dirty bleached look, quite unlike B. typhosus.	
" 82..	25 cc.	"	+						
" 83..	"	"	+						
" 84..	"	"	+						
" 85..	"	"	-	+V					
" 86..	"	"	+						
" 87.	400 cc.	S²	+						
" 88..	"	"	+						
" 89..	"	"	+						
" 90..	"	"	+						
" 91..	"	"	+						
" 92..	"	"	+						
" 93..	"	"	+						
" 94..	"	"	+						
" 95..	"	"	+						
" 96..	"	"	+						
" 97..	400 cc.	U²	+						
" 98..	"	"	+						
" 99..	"	"	+						
" 100..	"	"	+						
" 101..	"	"	+						
" 102..	"	"	+						
" 103..	"	"	+						
" 104..	"	"	+						
" 105..	"	"	+						
" 106..	"	"	+						
107..	1 cc.	W²	+						W² collected, January 3rd, 1902.

TABLE 14—*continued.*

Description of microbe and its source.			"Gas" in gelatine "shake" cultures, 20° C.	Chromogenic. Y=Yellow. G=Green. V=Violet.	Liquefaction of gelatine, 20° C.	Broth cultures at 37° C. N.G.=No growth.	Indol in broth cultures, 37° C.	Litmus milk cultures, 37° C.	Remarks.
Microbe 108 ..	2 cc.	W^2	-	-	-		-	Bleached appearance.	Morphologically unlike B. typhosus. Negative result with serum test.
„ 109 ..	„	„	+						
„ 110 ..	„	„	-	-	-	NG			
„ 111 ..	10 cc.	„	-	-	-	NG			
„ 112 ..	„	„	-	-	-	NG			
„ 113 ..	„	„	-	-	+				
„ 114 ..	„	„	+						
„ 115 ..	„	„	+						
„ 116 ..	20 cc.	„	+						
„ 117 ..	„	„	-	-	-	NG			
„ 118 ..	„	„	+						
„ 119 ..	„	„	-	-	-	NG			
„ 120 ..	„	„	+						
„ 121 ..	„	„	-	-	-	NG			
„ 122 ..	„	„	+						
„ 123 ..	50 cc.	„	-	-	-	NG			
„ 124 ..	„	„	-	-	-	NG			
„ 125 ..	„	„	-	-	-	NG			
„ 126 ..	„	„	-	-	-	NG			
„ 127 ..	„	„	-	-	-	NG			
„ 128 ..	1 cc.	Y^2	-	-	+				Y^2 collected, January 3rd, 1902.
„ 129 ..	„	„	-	-	+				
„ 130 ..	„	„	-	-	-		-	Acid clot.	
„ 131 ..	„	„	-	-	-		-	„ „	
„ 132 ..	„	„	+						
„ 133 ..	2 cc.	„	+						
„ 134 ..	„	„	-	+G					
„ 135 ..	„	„	-	+G					
„ 136 ..	„	„	-	-	-		-	Acid clot.	
„ 137 ..	„	„	-	-	-		-	„ „	

TABLE 14—*continued.*

Description of microbe and its source.			"Gas" in gelatine "shake" cultures, 20° C.	Chromogenic. Y—Yellow. G—Green. V—Violet.	Liquefaction of gelatine, 20° C.	Broth cultures at 37° C. N.G.—No growth.	Indol in broth cultures, 37° C.	Litmus milk cultures, 37° C.	Remarks.
Microbe 138 ..	10 cc.	Y^{3}	-	-	+				
" 139 ..	"	"	-	-	+				
" 140 ..	"	"	-	-	+				
" 141 ..	"	"	-	-	-		-	Acid clot.	
" 142 ..	"	"	-	-	+				
" 143 ..	"	"	-	-	+				
" 144 ..	20 cc.	"	-	-	+				
" 145 ..	"	"	-	-	+				
" 146 ..	"	"	-	-	-		-	Distinct alkali.	
" 147 ..	"	"	-	-	+				
" 148 ..	"	"	-	-	-		-	Acid clot.	
" 149 ..	"	"							Records as regards this microbe are lacking, due to some oversight.
" 150 ..	400 cc.	W^{3}	+						
" 151 ..	"	"	+						
" 152 ..	"	"	+						
" 153 ..	"	"	+						
" 154 ..	"	"	+						
" 155 ..	400 cc.	Y^{3}	+						
" 156 ..	"	"	+						
" 157 ..	"	"	+						
" 158 ..	"	"	+						
" 159 ..	"	"	+						
" 160 ..	1 cc.	$[3]^{3}$	-	-	-		-	Acid clot.	$[3]^{3}$ collected, January 15th, 1902.
" 161 ..	2 cc.	"	-	-	-		-	" "	
" 162 ..	"	"	-	-	-		-	" "	
" 163 ..	10 cc.	"	-	-	-	NG			
" 164 ..	"	"	-	-	-		-	" "	
" 165 ..	"	"	+						
" 166 ..	"	"	-	-	-		-	Acid clot.	
" 167 ..	"	"	-	-	-		-	" "	

TABLE 14—*continued.*

Description of microbe and its source.			"Gas" in gelatine "shake" cultures, 20° C.	Chromogenic. Y—Yellow. G—Green. V—Violet.	Liquefaction of gelatine, 20° C.	Broth cultures at 37° C. N.G.—No growth.	Indol in broth cultures, 37° C.	Litmus milk cultures, 37° C.	Remarks.
Microbe 168 ..	10 cc.	[3][2]	+						
" 169 ..	"	"	-	-	-		-	Acid clot.	
" 170 ..	20 cc.	"	-	-	+				
" 171 ..	"	"	-	-	-		-	Acid clot.	
" 172 ..	"	"	-	-	-		-	" "	
" 173 ..	"	"	-	-	-		-	" "	
" 174 ..	400 cc.	[1][2]	+						[1][2] collected January 15th 1902.
" 175 ..	"	"	-	-	+				
" 176 ..	"	"	-	-	+				
" 177 ..	"	"	-	-	-		-	Pale buff colour, quite unlike B. typhosus.	
" 178 ..	"	"	-	-	+				
" 179 ..	"	"	-	-	-		-	" "	
" 180 ..	"	"	-	-	+				
" 181 ..	"	"	-	-	+				
" 182 ..	"	"	-	-	+				
" 183 ..	"	"	-	-	+				
" 184 ..	"	"	-	-	+				
" 185 ..	"	"	-	-	+				
" 186 ..	400 cc.	[3][2]	+						
" 187 ..	"	"	+						
" 188 ..	"	"	+						
" 189 ..	"	"	-	-	-		-	Little or no change.	No morphological resemblance to B. typhosus. Serum test negative.
" 190 ..	"	"	-	-	-		-	" "	" "
" 191 ..	2 cc.	[5][2]	-	-	+				[5][2] collected January 22nd. 1902.
" 192 ..	10 cc.	"	+						
" 193 ..	"	"	+						
" 194 ..	"	"	-	-	-	NG			
" 195 ..	"	"	+						

TABLE 14—*continued.*

Description of microbe and its source.			"Gas" in gelatine "shake" cultures, 20° C.	Chromogenic. Y—Yellow. G—Green. V—Violet.	Liquefaction of gelatine, 20° C.	Broth cultures at 37° C. N.G.—No growth.	Indol in broth cultures, 37° C.	Litmus milk cultures, 37° C.	Remarks.
Microbe 196 ..	20 cc.	[5]*	+						
" 197 ..	50 cc.	"	-	-	-	NG			
" 198 ..	"	"	-	-	-	NG			
" 199 ..	"	"	-	-	-	NG			
" 200 ..	1 cc.	[7]*	-	-	-	NG			[7]* collected, January 22nd, 1902.
" 201 ..	2 cc.	"	-	-	-	NG			
" 202 ..	"	"	-	-	-	NG			
" 203 ..	"	"	-	+G					
" 204 ..	10 cc.	"	-	-	-		-	Acidity slight.	No morphological resemblance to B. typhosus. Serum test negative.
" 205 ..	"	"	-	-	-	NG			
" 206 ..	20 cc.	"	-	-	-	NG			
" 207 ..	"	"	-	-	-	NG			
" 208 ..	"	"	-	-	-	NG			
" 209 ..	50 cc.	"	-	-	-	NG			
" 210 ..	"	"	-	-	-	NG			
" 211 ..	400 cc.	[5]*	+						
" 212 ..	"	"	+						
" 213 ..	"	"	-	-	+				
" 214 ..	"	"	+						
" 215 ..	"	"	+						
" 216 ..	"	"	+						
" 217 ..	"	"	-	-	+				
" 218 ..	"	"	+						
" 219 ..	"	"	-	-	+				
" 220 ..	400 cc.	[7]*	+						
" 221 ..	"	"	+						
" 222 ..	"	"	+						
" 223 ..	"	"	+						
" 224 ..	"	"	-	-	+				
" 225 ..	"	"	+						

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The results shown in the foregoing table (Table 14) may be summarised as follows :—

"*Gas*" *in gelatine* "*shake*" *cultures*, microbes :—

1, 10, 11, 13, 31, 32, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 52, 54, 57, 59, 60, 61, 63, 68, 69, 71, 72, 73, 74, 75, 79, 82, 83, 84, 86, 87, 88, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, 100, 101, 102, 103, 104, 105, 106, 107, 109, 114, 115, 116, 118, 120, 122, 132, 133, 150, 151, 152, 153, 154, 155, 156, 157, 158, 159, 165, 168, 174, 186, 187, 188, 192, 193, 195, 196, 211, 212, 214, 215, 216, 218, 220, 221, 222, 223, 225.

Chromogenic, microbes :—

Green, 2, 134, 135, 203.

Yellow, 14, 15, 21, 26, 28, 30, 33, 35, 36.

Violet, 77, 85.

Liquefiers, microbes :—

5, 6, 7, 8, 17, 20, 23, 24, 25, 37, 50, 66, 76, 78, 80, 113, 128, 129, 138, 139, 140, 142, 143, 144, 145, 147, 170, 175, 176, 178, 180, 181, 182, 183, 184, 185, 191, 213, 217, 219, 224.

No growth in broth at 37° C., microbes :—

4, 9, 16, 110, 111, 112, 117, 119, 121, 123, 124, 125, 126, 127, 163, 194, 197, 198, 199, 200, 201, 202, 205, 206, 207, 208, 209, 210.

Indol in broth cultures, microbes :—

18, 27, 34.

Litmus milk cultures, microbes :—

Dirty bleached appearance, 3, 51, 53, 56, 58, 64, 67, 70, 81, 108.

Pale buff colour, 19, 49, 177, 179.

Acid clot, 55, 62, 65, 130, 131, 136, 137, 141, 148, 160, 161, 162, 164, 166, 167, 169, 171, 172, 173.

Alkali, 146.

Little or no change [*agglutination test*, negative], 189, 190.

? *Slight acidity* [*agglutination test*, negative], 204.

Strong acid, 12.

No growth in original sub-cultures, microbes :—

22, 29.

Record lacking, microbe :—

149.

From the foregoing summary it will be seen that the attempt to isolate B. typhosus among 225 microbes, derived from ten samples of well water, each from a different source but all from reputed fever areas, ended in failure.

PART III.

A.—Final Conclusions.

In drawing final conclusions it is desirable to consider both this year and last year's work together, the results obtained in each year being very similar in character.

A. *Chemical* (50 samples).

Not only could none of the fifty samples of Chichester well water have been condemned on the basis of the oxygen absorbed from permaganate test, but all of them would be classed as waters of great organic purity. Judged by the free ammonia test, two of the samples were most unsatisfactory, and another was suspicious. The remaining 47 samples contained an almost negligible amount of free ammonia. The albuminoid ammonia test served to condemn only three out of the 50 samples, and the majority of the samples would, judging by this test, be classed as water of great purity. It will be seen, then, that as judged by these tests the Chichester well waters were in general remarkably pure. The chlorine record, however, served to place a considerable number of the wells under the ban of suspicion. As so many of the well waters contained between two and three parts per 100,000 of chlorine, the figures being not uncommonly nearer two than three parts per 100,000, it will probably be reasonable to regard with suspicion all those samples yielding over three parts per 100,000. In this view of the case, 21 samples, or rather less than 50 per cent., were open to suspicion of objectionable pollution.

B. *Bacteriological* (50 samples).

(1.) The *general results and inferences* are as follows :—

(*a*.) *Total number of bacteria per cc*:—In 10 samples, 1,000 but less than 10,000 ; in 21 samples, 100 but less than 1,000 ; in 15 samples, 10 but less than 100 ; in 4 samples, less than 10.

(*b*.) "*Gas*" *in gelatine* "*shake*" *cultures* (24 hours at 20° C.).—In 2 samples, + 10 cc. – 1 cc. ; in 8 samples, + 100 cc. – 10 cc. ; in 40 samples, – 100 cc.

(*c*.) *B. coli* (*and allied forms*).*—In 10 samples, + 0·1 cc. ; in 18 samples, + 10 cc. – 0·1 cc. ; in 12 samples, + 100 cc. – 10 cc. ; in 10 samples, – 100 cc.

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* Last year the presence or absence of B. coli in 1 cc. of the water was not determined. This year nine out of 20 samples contained B. coli in 1 cc., of these B. coli was absent from 0·1 cc. in five of these nine samples.

(*d.*) *Spores of B. enteritidis sporogenes* (Klein).—In 3 (? 4) samples, + 100 cc. — 10 cc.; in 2 (? 3) samples, + 200 cc. – 100 cc.; in 45 (? 43) samples, — 200 cc.

(*e.*) *Streptococci.*—In 5 (? 9) samples, + 10 cc.; in 45 (? 41) samples, — 10 cc.

(*f.*) *Search for B. typhosus.*—60 samples (including Part II.) were examined. 456 microbes were studied. The results were wholly negative.

(2.)* These general results *may* be interpreted as indicating nothing more than that some of the waters were polluted and that others were of great bacterial purity.

(3.) But it may be questioned whether they do not indicate something more than this; namely, that the waters in general were possessed of intrinsic biological qualities pointing to their late association with matters of intestinal sort.†

(4.) Biological qualities such as the above are not proper to waters derived from pure sources; moreover they are apt to be masked chemically by the mechanical filtering action of the soil.

(5.) If this view be correct, immunity from danger in drinking such waters would be relative, not absolute.

(6.) The circumstance that the inhabitants of Chichester drawing their water supply from these local wells have not seemingly suffered to any conspicuous extent from enteric fever in the past, may possibly be referred, not to the complete absence of dangerous pollution of well waters, but to the beneficial mechanical action of the soil in reducing the amount of morbific poison contained in the soil water.

(7.) The facts observed by me at Chichester lend some support to Dr. Thomson's tentative hypothesis that soil plays some part in "fostering and localising" enteric fever in this town, inasmuch as the well waters representing the more or less perfectly filtered "washings" of soil nevertheless possessed certain biological qualities suggestive of fouling with matters of intestinal outcome. Qualities not inconsistent with the supposition that possibly the soil at Chichester fosters in a higher degree than most soils "the vitality and morbific power of the infective material of enteric fever."

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* From this point I quote from last year's report as my subsequent work has tended to confirm my previous conclusions.

† It is a point not to be lost sight of that although the well waters frequently contained but few bacteria, the ratio of the objectionable microbes to the total bacterial flora was often highly significant of animal pollution.

(8.) B. typhosus could not be found in any of the samples examined. But B. coli (or closely allied forms) was found in a majority of the waters; and further, a small percentage of these coli-like microbes gave a positive result by the agglutination test, with human typhoid, with the blood of a typhoid immunised guinea-pig, or with blood of both sorts.

Epidemiologists, in the past, have shrunk from accepting too readily the unsupported testimony of bacteriologists as regards the purity or otherwise of drinking water supplies. Nor is this on the whole to be wondered at. Yet when the modern methods of responsible bacteriologists of *measuring* the probable degree of potential danger to health by means of *quantitative* and *qualitative* biological tests of proved efficiency are considered the scepticism of the epidemiologist is less reasonable than in the past. It requires no seer to prophesy that the future progress of preventive medicine in connection with drinking water supplies lies in a happy recognition of the claims not only of the epidemiologist but also of the bacteriologist and, although in a minor degree, of the chemist and the geologist to investigate the problem.

B.—Recommendations.

Recommendations in a report of this kind may seem out of place. But having regard to the unfortunate history of Chichester in respect of enteric fever, the time and labour expended on the analyses of the well waters, and the fact that notwithstanding the prolonged investigations of the Board's Inspectors, the cause of the disease is still unhappily obscure and a matter for conjecture and hypothesis, it seems not unreasonable to inquire whether the results of this well-water inquiry have thrown any light on the subject from a *remedial point of view.*

To answer this question is not easy, the more so since both Dr. Thomson and Dr. Bulstrode came to the conclusion that the well-water drinkers have not suffered in the past to a *conspicuously* greater extent than those obtaining their supply from the public-water service. But so far as the plain facts of the case are concerned, and looking at the subject solely from the bacteriological point of view, unfettered by attention to the opinion of others, however well balanced and authoritative these opinions may be, I cannot but think that my results go far to implicate the Chichester well waters as a constant, (although not perhaps a serious), menace to a section of the inhabitants. For I have little doubt that my results will be interpreted as tending to show that the well waters in general, although seemingly relatively pure owing to the beneficial filtering action of the soil, were, nevertheless, possessed of certain intrinsic biological qualities suggestive of fouling with matters of intestinal sort. Pollution of this sort be it noted, although seemingly trivial in amount, may yet be the means of causing widespread disease. Further, it may be questioned whether the topographical position of well waters is always a safe indication of the real range and extent of their

influence, that is to say, of the population who are *casual* as well as *consistent* well-water drinkers. For example, Well T (D of last year) is situated in the open space of the cattle market, and although nominally a closed pump well is covered by a detachable iron covering. That objectionable organic matters may occasionally find their way into the well is extremely likely. Last year it is true the water was not seriously implicated although the oxidised nitrogen was as high as 0·72 parts per 100,000, but this year a sample contained B. coli (or allied form) in 1 cc. of the water, and in both years the chlorine figures were somewhat suspicious. Such a well water would be likely to be drunk by many individuals widely separated as regards their respective domiciles.

Yet I am far from contending that the well waters in general are "heavily implicated" in the propagation of enteric fever in Chichester.

All that I would seek to show is that, although the cause of the "continued prevalence in serious amount of enteric fever in Chichester" still remains obscure, there is some evidence in favour of the view that the well waters may play a part in spreading the disease. The need for amelioration of these conditions is too imperative to allow of the objection that the pollution of the wells is but one (possibly even an insignificant one) of the many factors which together constitute the total and unenviable liability of the inhabitants of Chichester to be exposed at some period of their existence to the risk of contracting enteric fever.

Assuming these contentions to be correct, my sole recommendation is that the wells be gradually closed, either on the considerations embodied in the results of my analyses or on the results of the analyses of competent and independent experts. It is here assumed, as is alleged, that the public water service is satisfactory both as regards quality and quantity.

ADDENDUM A.

CITY OF CHICHESTER.—LEVELS OF SUB-SOIL WATER, IN FEET ABOVE ORDNANCE DATUM.

Date.	*Well A.	Well B.	Well C.	Well D.	Well E.	Well F.	Well G.
1901.							
January 7	30·30	32·98	32·43	29·20	27·65	28·30	29·49
„ 14	30·47	33·27	32·68	29·20	27·70	28·34	29·57
„ 21	30·47	33·48	32·76	29·12	27·74	28·38	29·66
„ 28	30·47	33·48	32·76	29·16	27·82	28·38	29·66
February 4	30·47	33·60	32·80	29·16	27·82	28·42	29·70
„ 11	30·76	33·69	33·01	29·41	28·07	28·67	29·87
„ 18	30·93	34·14	33·34	29·45	28·12	28·84	30·08
„ 25	30·76	34·39	33·47	29·41	28·12	28·88	30·08
March 4	30·72	34·44	33·55	29·37	28·12	28·84	30·08
„ 11	30·72	34·64	33·68	29·45	28·12	28·84	29·99
„ 18	30·80	35·14	34·01	29·53	28·16	28·92	30·08
„ 25	30·88	36·10	34·51	29·58	28·16	29·00	30·08
April 1	31·01	36·73	34·93	29·70	28·24	29·09	30·20
„ 8	31·58	36·89	35·06	30·28	28·70	29·67	30·94
„ 15	32·47	38·35	35·89	30·74	29·24	30·34	31·82
„ 22	33·13	38·81	36·26	31·08	28·74	31·26	32·16
„ 29	33·38	38·98	36·51	31·28	30·07	31·67	32·53
May 6	33·47	39·14	36·64	31·45	30·28	31·88	32·66
„ 13	33·51	Max. 39·89	Max. 37·82	31·58	30·32	32·01	32·78
„ 20	Max. 33·76	39·64	37·09	31·62	30·41	Max. 32·22	Max. 32·95
„ 27	33·68	39·52	37·05	Max. 31·70	Max. 30·45	32·22	32·95
June 3	33·59	38·98	36·76	31·66	30·45	32·13	32·87
„ 10	33·34	38·73	36·59	31·53	30·36	32·13	32·70
„ 17	32·97	38·39	36·22	31·53	30·24	31·84	32·45
„ 24	32·88	37·98	35·93	31·37	30·16	31·67	32·35
July 1	32·80	37·69	35 80	31·37	30·16	31·63	32·24
„ 8	32·59	37·56	35·55	31·24	30·03	31·38	31·99
„ 15	32·51	37·06	35·30	31·03	29·74	31·05	31·75
„ 22	32 13	36·89	35·09	30·91	29·57	30·72	31·45
„ 29	31·63	36·73	34·93	30·74	29·41	30·51	31·24

* The wells are indicated on the accompanying map by blue dots and letters.

APP. B, No. 7.

On the Chemical and Bacteriological Examination of Chichester Well Water; by Dr. Houston.

SUB-SOIL WATER LEVELS—*continued.*

Date.	*Well A.	Well B.	Well C.	Well D.	Well E.	Well F.	Well G.
1901.							
August 5	31·34	36·39	34·72	30·68	29·07	30·13	30·87
" 12	31·13	36·23	34·64	30·41	28·95	29·92	30·70
" 19	31·05	35·98	34·47	30·33	28·91	29·76	30·58
" 26	30·80	35·52	34·28	30·12	28·66	29·51	30·32
September 2	30·59	35·39	34·09	29·95	28·53	29·34	30·12
" 9	30·42	34·98	33·97	29·78	28·37	29·09	29·95
" 16	30·22	34·73	33·76	29·66	28·24	28·92	29·82
" 23	30·22	34·56	33·59	29·58	28·07	28·92	29·78
" 30	30·13	34·19	33·30	29·41	28·03	28·72	29·62
October 7	30·01	33·89	33·14	29·33	27·82	28·67	29·57
" 14	30·01	33·60	32·93	29·20	27·78	28·55	29·41
" 21	29·88	33·56	32·84	29·03	27·66	28·38	29·37
" 28	29·98	33·30	32·59	29·03	27·62	28·38	29·28
November 4	29·71	33·06	32·42	28·90	27·49	28·17	29·28
" 11	29·71	32·78	32·21	28·82	27·32	28·17	29·12
" 18	29·63	32·64	32·01	28·74	27·28	28·01	29·03
" 25	29·50	32·39	31·84	28·62	27·16	27·96	29·07
December 2	29·43	33·27	31·68	28·49	27·16	27·93	28·95
" 9	29·43	32·14	35·59	28·44	26·98	27·92	28·91
" 16	29·43	32·06	31·59	28·44	27·07	27·87	28·90
" 23	29·58	31·94	31·43	28·37	26·95	27·80	28 91
" 30	29·88	31·94	31·43	28·45	27·07	27·97	28·90
1902.							
January 6	30·13	32·22	31·88	28·99	27·32	28·17	29·20
" 13	30·25	32·64	32·09	28·99	27·32	28·62	29·63
" 20	30·26	32·77	32·28	28·83	27·45	28·21	29·41
" 27	30·13	32·98	32·34	28·87	27·40	28·21	29·45
February 3	30·08	32·84	32·25	28·78	27·40	28·17	29·28
" 10	29·92	32·84	32·21	28·70	27·37	28·01	29·28
" 17	29·79	32·72	33·13	28·65	27·28	27·88	29·12
24	29·79	32·60	32·01	28·62	27·24	27·84	29·20
March 3	30·03	32·72	32·29	29·03	27·45	28·01	29·28
" 10	30·59	33·06	32·56	29·08	27·57	28·13	29·53
" 17	30·59	33·39	32·72	29·03	27·66	28·26	29·71

* The wells are indicated on the accompanying map by blue dots and letters

App. B, No. 7.

On the Chemical and Bacteriological Examination of Chichester Well Water; by Dr. Houston.

ADDENDUM B.

RAINFALL (in inches) AT SEWAGE WORKS (CHICHESTER).

1901.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
1	·10	—	·02	·01	—	·04	—	—	—	·19	—	—
2	—	·50	·13	·08	—	—	·60	—	—	—	—	·02
3	—	—	·03	·64	—	—	—	—	—	·15	—	—
4	—	·44	·18	—	—	—	—	·03	—	·40	—	—
5	—	·23	·16	·25	—	—	—	·16	—	—	—	·05
6	—	—	·14	·27	·10	—	—	·01	·01	·06	—	·04
7	·15	—	·07	·11	—	—	—	—	·01	—	—	·18
8	·16	—	·03	·02	·10	—	—	—	·26	·13	—	·81
9	—	—	—	·10	·10	—	—	—	—	—	—	·10
10	—	—	—	·20	—	—	—	·02	—	—	—	—
11	—	—	—	·23	—	—	—	·18	·11	—	·05	·31
12	—	—	—	—	—	·14	—	·02	—	—	·10	·62
13	—	—	—	·26	—	·10	—	—	—	—	·08	·08
14	—	—	—	·09	—	—	·06	·40	—	—	—	—
15	—	—	·21	·10	—	—	—	·08	—	·12	—	—
16	·10	—	—	·03	—	—	—	—	1·23	·26	—	—
17	·02	—	—	—	—	—	—	—	·25	·11	—	·11
18	·14	·04	—	—	—	—	—	—	—	·65	·08	—
19	—	·02	·09	—	—	·20	—	—	—	·06	—	—
20	—	—	·30	—	—	·08	—	—	·04	·12	—	—
21	—	·04	—	—	—	·46	—	—	·01	·11	·06	—
22	·01	—	—	—	—	—	—	—	·05	·10	·02	—
23	—	—	—	—	—	—	·20	—	·02	—	—	·50
24	·03	—	—	—	—	—	·20	—	—	·20	—	·45
25	·02	—	·03	—	·02	—	·88	·27	—	—	—	·02
26	·10	·18	—	—	—	—	·24	·02	—	—	—	—
27	·03	·02	·01	·01	—	—	·25	·31	—	—	—	·06
28	·07	·35	—	—	—	—	—	—	—	—	—	·49
29	—	—	·02	—	·02	·78	—	—	—	·04	—	·41
30	—	—	·81	—	·18	1·32	—	—	—	—	—	·13
31	—	—	·12	—	—	—	—	·01	—	—	—	·12
Totals	0·93	1·87	2·35	2·40	0·52	3·12	2·43	1·51	1·99	2·69	0·39	4·53

Total rainfall for year 1901, 24·73 inches.

Rainfall (in inches) at Sewage Works—*continued.*

1902.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
1	·34	·02	·04									
2	—	—										
3	·01	·03										
4	·05	—										
5	—	—										
6	—	·19										
7	—	·02										
8	—	·03										
9	·06	—										
10	—	—										
11	—	·03										
12	—	—										
13	—	—										
14	—	—										
15	·03	—										
16	—	—										
17	—	—										
18	—	—										
19	—	—										
20	—	—										
21	·02	—										
22	—	·34										
23	—	·35										
24	·07	·42										
25	—	·09										
26	·31	·45										
27	—	·09										
28	·11	·02										
29	—	—										
30	—	—										
31	—	—										
Totals	1·00	2·08										

APP. B, NO. 7.

On the Chemical and Bacteriological Examination of Chichester Well Water; by Dr. Houston.

ADDENDUM C.

CITY OF CHICHESTER.—HOUSES ATTACKED BY ENTERIC FEVER.

1900.			
December 13th	J— J — S— ..	Aged 3 years	22, Westgate.

NOTE.—The above case is not marked on the spot map. The following are all marked on accompanying map (red dots).

1901.			
January 19th	E— M—	Aged 40 years	117, Oving Road.
April 14th	G— D—	„ 21 „	1, Cooper Street.
„ 15th	W— A—	„ 12 „	15, High Street.
May 11th	J —J—	„ 10 „	22, Chapel Street.
June 13th	A— B—	„ 42 „	215, Oving Road.
„ 18th	F— R—	„ 21 „	120, St. Pancras.
„ 18th	D— L—	„ 16 „	4, North Street.
„ 18th	M— A— H— ..	„ 34 „	2, Franklin Place.
July 8th	A— K—	„ 14 „	68, High Street.
August 10th	W— L—	„ 21 „	30, St. Pancras.
September 2nd ..	V— B —	„ 11 „	40, George Street.
„ 23rd ..	A — L—	„ 13 „	38, Tower Street.
„ 30th ..	H— B—	„ 3 „	4, Alexandra Terrace.
October 4th	L— W—	„ 26 „	22, Adelaide Road.
„ 7th	E— G—	„ 21 „	51, High Street.
November 3rd	W— T—	„ 18 „	16, Franklin Place.
December 19th	E— C—	„ 22 „	The Infirmary.

Making a total for the year 1901 of 17 cases.

During the present year (to end of March) 1902, no case of typhoid fever has been notified at Chichester.

No. 8.

APP. B, No. 8.

The Micro-pathology of Hæmorrhagic Small-pox; by Dr. Klein, F.R.S.

The Micro-pathology of Hæmorrhagic Small-pox; by Dr. E. Klein, F.R.S.

(*Plates II.-V.; Figures* 1–8.)

The question of the intimate nature of hæmorrhagic small-pox in man is, according to all authorities, an unsolved one. It is quite unknown what determines the hæmorrhagic condition in variola. This condition seemingly is not due to the severity of the disease *per se*, or to the unprotected condition of the individual, though it is admitted on all sides that hæmorrhagic small-pox is of an extremely infectious nature. It has been affirmed that hæmorrhagic small-pox is due to a complication of the small-pox by septic microbes; that is to say, that in addition to the (unknown) microbe of small-pox there has entered the system of the affected individual some septic organism which is the real cause of the hæmorrhagic complication. Dr. Maurice has asserted that in a large number of cases of hæmorrhagic variola he actually found in the blood septic organisms, and from this he concludes (and with him also others) that it is the entrance of such septic microbes into the blood which converts an ordinary case of small-pox into one of hæmorrhagic variola.

That this explanation is incorrect there is no difficulty in showing, since the various septic organisms which are found in the blood and viscera of fatal cases of confluent small-pox do not differ from those occurring in cases of hæmorrhagic small-pox. Thus, I myself have in previous years and in former small-pox epidemics examined by culture the blood of a number of fatal cases of confluent small-pox with the result of finding in it a considerable variety of micro-organisms; and during the present year's epidemic Drs. Drysdale and Scholberg have done the like. In most cases they found present therein and easily demonstrable the various species of microbes—as, for instance, non-pathogenic staphylococci and particularly streptococci and bacilli of various kinds—which may be also obtained from the blood in some cases of hæmorrhagic variola. Later on I shall deal in detail with these microbes. For the present it is enough to state the fact that such microbes are present in the blood of small-pox patients, and to point out that this is hardly matter for surprise when it is borne in mind that in confluent small-pox and in hæmorrhagic small-pox we have diseases of great severity associated with a universal disorganization of the tissues and organs. Under such conditions the entry into the blood, and their multiplication therein, of microbes from the respiratory and alimentary organs is not to be wondered at; microbes which having no part either in the disease or in its fatal issue are in this connexion true saprophytes. This is seen also constantly in the post-mortem room, where very often, in human corpses not dead of small-pox but which succumbed to one or another kind of severe illness (typhoid fever, dysentery, pneumonia), such saprophytes are met with in

the blood. The presence therefore of septic bacteria in the blood cannot be accepted as a determining cause of the hæmorrhagic complication of small-pox. This view does not in the least deny that this hæmorrhagic condition is caused by a microbe, nor that this microbe might be specifically different from that causing ordinary small-pox. The fact that a hæmorrhagic case of small-pox may be the result of infection from a non-hæmorrhagic one, and that *vice versâ* a hæmorrhagic may and generally does give rise to an ordinary case of small-pox, is consistent with the virus of small-pox being something different from the essential cause of the hæmorrhagic condition.

The clinician, to judge from what one constantly hears in medical societies and from what one reads in text books, does not, during a small-pox epidemic, seem to have any hesitation in pronouncing (with or without demonstrable contagion) as hæmorrhagic small-pox any case of acute febrile disease destitute of papular or vesicular eruption but exhibiting hæmorrhagic spots and patches having the peculiar distribution known as "bathing-drawer appearances"; *i.e.*, the manifestation of conspicuous hæmorrhages on the lower abdomen and upper part of the thighs. Of course such clinician would not hesitate to pronounce as hæmorrhagic small-pox any case in which the eruption characteristic of small-pox was modified in the sense that the vesicles contained effused blood. The first kind of appearances (hæmorrhagic spots and patches) the clinician distinguishes (*see* Liebermeister Vol. Infections Krankheiten, p. 172) from the second (*i.e.*, the vesicular hæmorrhagic) by inferring that the patient in the former did not reach the stage of vesiculation (purpura variolosa), whereas in the latter this stage had been attained. It will presently be seen that from a histological and pathological point of view identification of the former class of case as variola is an assumption which certainly requires confirmation, unless of course such case is definitely traceable to contagion. In the absence of circumstantial evidence this cannot be accepted as proven.

I now proceed to cite a particular case of a hæmorrhagic acute febrile disease which by most clinicians would be, and as a matter of fact has been, classed as hæmorrhagic small-pox. This is a case of a nurse, T., who was under the care of Sir Hugh Beevor. She was taken ill on 4th December, and she died on 9th December. The post-mortem was ordered by the Medical Officer of the London County Council, Mr. Shirley Murphy, to whom one of the attending physicians had notified the case as possibly one of hæmorrhagic plague. Mr. Shirley Murphy and Dr. Hamer, and particularly Dr. Goodall, were of the decided opinion that the case was one of hæmorrhagic small-pox. The following is a brief abstract of the history of the case from the published account of it:—

> "The patient was a nurse (Nurse T.), aged 42 years. For
> "some three or four weeks she had been engaged in nurs-
> "ing a man suffering from a third relapse of acute rheuma-
> "tism, in a house near the Strand.

"Nurse T. did not sleep in the house occupied by her "patient. She slept in the Home, took her meals in the "patient's house, another nurse from the Home being "employed on night duty on the same case, returning in "the same way to the Home to sleep. Nurse T. had been "engaged in this way for about two months, the last three "weeks on night duty. The only exception to this occu-"pation of her time was a visit she made to Gravesend, on "13th November, to see a relative who had enteric fever. "She slept at Gravesend one night. She may, however, "have gone out in the day time if sent on a commission "by her patient's family.

"There had been no illness among the nurses at the "Home during 1901, and none of them had recently been "in attendance on a case of infectious disease. Dr. Young, "however, ascertained that, with the object of gaining "experience in the nursing of small-pox, two nurses from "the Home had been for a period at the small-pox hospital "ships. The first of these, Nurse C., went to the ships on "2nd September, left the ships on 23rd November and "went to the "shelter" on shore, where she remained till "27th November, and then returned to the Home. She slept "at the Home one night and then went to Halifax. She "remained in good health. She was a friend of Nurse T., "and they probably met at the Home.

"The other (Nurse L.) went to the ships on 23rd "September. She left the ships on 23rd November and "returned to the Home, where she remained until 27th "November, when she returned to the ships.

"Nurse T. may, therefore, have come in contact with "Nurse C. on 27th November and 28th November, and "with Nurse L. on the four days 23rd November to 27th "November. Nurse T. began to be ill on 4th December. "If infected by C. the incubation period would not be "more than seven days, if by L. not more than 11 days.

"Nurse T. was unwell on 4th December. She came "home, and the following morning, the 5th, was unable to "get up. She felt sick and had headache. On the 6th she "was no better, and thought she had influenza. On the 7th "she was considerably worse. . . . Wishing to see the "rash by daylight, I went early the next morning, Sunday "(8th December), she was much worse, and evidently going "to die; semi-comatose, face deeply dusky, conjunctivæ "deep yellow with hæmorrhages, tongue swollen and thickly "furred; trunk with chest and abdomen appeared to have "got much darker, a deep brown colour, and smothered all "over with hæmorrhagic spots, which gradually extended "to the limbs—a typhus rash—and she died comatosed that "night. The temperature, which had risen up to 104° "Fahrenheit, fell to 98° five hours before her death.

"Post-mortem on 9th. On exposing the surface of the "abdomen, the lower part was found to be covered with a

" purpuric eruption, consisting of thickly-set pin-point " petechiæ with larger blotches, some of which were the " size of a split pea. The eruption was especially marked, " roughly speaking, in a triangular area included between " a transverse line drawn through the umbilicus and " bounded below by two lines drawn across the front of " the thighs parallel to and a few inches below Poupart's " ligaments. Two chains of more scattered petechiæ ex-" tended from the main area of eruption upwards towards " the arm-pits. On the arms and lower legs there were " purpuric blotches here and there, but the main develop-" ment of the eruption was in the situation already defined. " There were conjunctival hæmorrhages and minute " petechiæ on the pericardium. The pericardial sac con-" tained several ounces of fluid. The appearances of the " eruption and of the conjunctivæ were those characteristic " of hæmorrhagic small-pox. The lungs had a few " petechiæ, but otherwise seemed healthy."

Material was furnished me from this body: blood which had been withdrawn aseptically from the right ventricle by means of freshly drawn out glass capillary pipettes, afterwards sealed; and pieces of lung and pieces of skin of the abdominal and femoral region, which had been cut out under all necessary precautions. In the laboratory these samples were used for cultivation and experiment, pieces of the lung and of the skin being also placed into Müller's fluid for hardening.

The heart's blood was used thus: —

1. Film specimens were made and stained;
2. Agar surface plates were inoculated and incubated at 37° C.;
3. Guinea-pigs were subcutaneously injected.

The above proceedings were undertaken for demonstration of the presence of plague bacilli, the case having, as already mentioned, been notified as possibly plague.

Examination of specimens of the heart's blood yielded the following results:—

Microscopic film specimens, stained, showed numerous capsulated diplococci—each diplococcus consisting of two demilunes closely facing each other and invested in a distinct capsule. They were arranged either as single diplococci or more commonly as short (2 diplococci) and longer chains (4 diplococci). Fig. 1, Plate II., shows a specimen of this kind. Not every microscopic field of the specimen contained these capsulated diplococci in such numbers as is shown in Fig. 1; nevertheless the microbe was on the whole very abundant, and it was obvious from microscopic examination alone that the case was distinctly one of blood infection—infection due, that is, to Diplococcus capsulatus, the exact nature of which could of course only be determined by culture and by animal experiment.

The agar surface plate made from the original blood showed next day (but better still after 48 hours) an uncountable number

of translucent grey colonies, in many places confluent into a grey filmy layer. These colonies in their general aspect were identical with those of Diplococcus pneumoniæ, and, like the latter, were made up of diplococci, either altogether wanting in capsule or possessed only of an indication of it. So too they were chiefly arranged as chains, some of these chains being composed of as many as 18 to 20 diplococci. A small amount of the growth, a few colonies only, was used for making an emulsion, and with this emulsion mice and guinea-pigs were injected subcutaneously. The result was perfectly distinct and uniform; the guinea-pigs showed no illness, while the mice died. The post-mortem appearances in the latter case were those found in mice after infection with the Diplococcus pneumoniæ; the œdematous fluid of the seat of inoculation was found crowded with the capsulated diplococcus, either as single diplococci or as short chains of two elements. Fig. 2, Plate II., is a characteristic specimen of this kind, the capsules being shown with great distinctness.

There can then be no question as to the identity of this microbe. It was the Diplococcus pneumoniæ, and it was present in the blood of the patient T. in very large numbers. As already mentioned, this patient had no pneumonia, while at the post-mortem examination only a few petechiæ were found in the lung. The case, therefore, was undoubtedly one of general blood infection with the Diplococcus pneumoniæ. That such a general infection—viz., copious presence of the microbe in the blood—existed in this case ante mortem may be taken as certain; cold weather prevailed at the time (9th December), moreover the blood was obtained within 12 hours of death. It is altogether improbable, therefore, that an appreciable multiplication of the microbe had taken place after death, since the Diplococcus pneumoniæ requires for its growth and multiplication higher temperatures than could have obtained here. Below 25° C. the growth of this microbe in the laboratory is either nil or very delayed and slow.

The abundant presence in the circulation of a virulent microbe like the Diplococcus pneumoniæ must needs be of considerable importance, and in the particular instance may well have caused the severe constitutional illness and death. As will presently be seen, the microbe was present also in the skin in the hæmorrhagic spots, and although it may have been so present as a result of blood effusion, it might, on the other hand, by its intravascular toxin have been the primary cause of the destructive (chemical) vascular change leading to the hæmorrhage. It is well known that many microbes have such an (vascular) angiolytic action; as for instance all the pathogenic microbes which grow and multiply within the circulation, such as the whole group of bacilli causing hæmorrhagic septicæmia. To these must be added the Bacillus pestis, the Bacillus anthracis, the Diplococcus (lanceolatus) pneumoniæ (when injected into the vascular system*), and as

* The diplococcus pneumoniæ seems to be capable of causing vascular disruption, even when growing outside but close to capillaries, *e.g.*, the hæmorrhage into the exudation of the alveoli of the lung in acute croupous pneumonia causing the "rusty sputum."

well some species of streptococcus and some virulent species of Bacillus coli (*e.g.*, bacillus of aerobic malignant œdema, bacillus of Gærtner, bacillus of Danysz, and others). The destruction (chemical solution) of the wall of minute blood vessels by the toxins of many microbes growing and multiplying within the circulation is indeed a well-known fact, and accordingly the hæmorrhage in the skin of Nurse T. may have been due to the copious presence of the Diplococcus pneumoniæ within the circulation.

The questions therefore that arise in connexion with this case are these : If this was really a case of small-pox, was the presence of the Diplococcus pneumoniæ the cause of the hæmorrhagic condition ; and is it also the cause of the hæmorrhagic condition in other cases of small-pox ?

Before proceeding to seek for an answer to these questions it is necessary first to supplement the bacterioscopic analysis of the case of Nurse T.

The Diplococcus pneumoniæ present in this case in the blood (*see* film specimens and culture plate) in enormous numbers was not the only microbe found therein. In the film specimens of the blood now and again, but on the whole very sparsely, there were found single microbes without capsule which on more careful examination were recognised as oval bacilli. On the agar plate, too, above-mentioned, which had uncountable translucent small grey colonies of the Diplococcus pneumoniæ, there were present in addition, after 24 hours incubation, 8–12 colonies of an altogether different character. These were heaped up, whitish grey, round to irregular colonies several times larger than those of the Diplococcus pneumoniæ. Such colonies were composed of a viscid slimy material which under the microscope was seen to be made up of a hyaline transparent viscid interstitial or ground substance in which were embedded in close juxtaposition oval to cylindrical non-motile rods, thus representing a typical zooglœa mass. In stained films the bipolar staining of the rods was very distinct (Fig. 3, Plate III.) ; so that these bacilli are not dissimilar to those of Bacillus pestis. Subcultures were made from the primary colonies in the different media, and in these the characters of the microbe were found similar to those of microbes constituting the group of bacillus of Friedländer, but with this difference, namely, that the growth of the microbe in question was quicker, and that it formed more pronounced viscid slimy masses. Another point which distinguishes it from the Bacillus Friedländer is that in culture it formed distinct zooglea ; that is to say, the individual bacilli are barren of a separate capsule like the typical bacillus of Friedländer, but unlike that microbe are embedded in, and held together by, a slimy interstitial substance. The character, aspect, and rapid growth of the colonies, as well as their mode of growth in the different media, seems in general to distinguish this microbe from the Bacillus pestis which it closely resembles as regards polar staining, and also as regards length and thickness. Owing to the conspicuously slimy character of the growth of this microbe I propose calling it Bacterium myxoides. For the rest, in a

general way it presents the characters of the microbes belonging to the group of Bacillus Friedländer ; like these it does not stain by Gram's method, and does not liquefy gelatine.

A point of constant difference between this B. myxoides and B. Friedländer is that the former taken from the animal tissues does not under any circumstance show a capsule. This of course can be demonstrated readily in the tissues after inoculation into animals.

Guinea-pigs and rats were, with the pure culture of B. myxoides, injected cutaneously and subcutaneously. But no effect whatever was hereby produced; the animals remained well. This of course proved also experimentally that the microbe was not B. pestis.

Intraperitoneal injection of the microbe into guinea-pigs, however, even in small doses, caused invariably a fatal result in 20–30 hours. The post-mortem appearances were as follows:—Copious grey viscid peritoneal exudation; intestines much inflamed; liver, spleen, and kidneys highly congested.

The peritoneal exudation of these guinea pigs in stained film specimens showed crowds of oval to cylindrical bacilli, often in couples end to end. The conspicuous thing about them was their exquisite bipolar staining (*see* Fig. 4, Plate III.); no leucocytes, and no other microbes were present. Plate cultures proved that the exudation was a pure culture of Bacterium myxoides. There was nowhere any indication of a capsule around individual bacilli, but the matrix in which the bacilli were embedded was a homogeneous viscid stainable substance, similar to that mentioned in regard of the zoogloea matrix of the culture.

The blood of these guinea-pigs contained a very large number of the same microbes, viz., the B. myxoides; so much so that in a dried and stained film specimen of the heart's blood every field of the microscope contained great numbers of the bacilli (Fig. 5, Plate IV.); some fields indeed, *e.g.*, Fig. 6, Plate IV., appeared crowded. The bacilli showed no trace of a capsule, but they all showed very distinct bipolar staining. The majority of the bacilli in the blood were rounded at both ends, but some showed one end, seldom both, as if cut away. The bacilli in the blood were distinctly thicker than those of plague.

The subcutaneous injection of culture of the microbe into mice always produced acute disease and death in three to four days. At the seat of inoculation inflammation and gangrene was apparent; the spleen was found enlarged, congested; the peritonium inflamed; all the viscera were hyperæmic. The bacilli (B. myxoides) were readily demonstrated by film specimens and in culture, being very numerously present at the seat of injection, in the blood, in the spleen, and particularly in the peritoneal exudation; the latter appearad densely crowded with them. Rabbits are unsusceptible alike to subcutaneous and intravenous injection of large doses of culture.

It has been shown then that in the blood of Nurse T. there were present two virulent species of microbes. The one, the Diplococcus pneumoniæ, in enormous numbers, so much so that its presence in the blood would be quite sufficient to account for the severe illness and death with hæmorrhages; the other microbe, the B. myxoides, although not present in large numbers, is nevertheless a microbe pathogenic for certain rodents. This B. myxoides, which morphologically and in staining presents a certain resemblance to B. pestis, has cultural characters sufficiently distinct to differentiate it from the plague bacillus.

The clinical experts, particularly Dr. Murphy and Dr. Goodall who have seen a good many cases of hæmorrhagic small-pox, being emphatic as to this nurse's disease being hæmorrhagic variola, I was desirous of ascertaining whether the microscopic examination of the hæmorrhagic eruption of the skin could throw any further light on the subject. It is well known that in the vesicular stage of variola, as also of vaccinia, the layers of the epidermis represented by the stratum malphigii are the seat of the vesiculation; that is to say, cavities having formed there become filled with clear fluid. In hæmorrhagic small-pox not only do the vesicles contain blood but blood is effused also immediately underneath the vesicles in the upper part of the corium. Fig. 8, Plate V., represents a section through the skin of hæmorrhagic small-pox in the early phase of the vesicular stage. The section had been stained in a mixture of methylblue and eosin; the epidermis appears stained blue (methylblue), the blood and connective tissues are stained pink (eosin). There is seen effused blood in substance in immediate contact with the lower wall of the vesicle, which is formed by the deepest layer of the stratum malphigii and the papillary or superficial layer of the corium; also in the fluid of the vesicle clumps of blood corpuscles are to be noticed. The deeper layer of the corium and the superficial layer of the subcutaneous tissues are, it will be observed, free of any effused blood.

The specimen in question was from a typical case of hæmorrhagic small-pox fatal on the fourth day after the first appearance of the rash. It is in marked contrast with Fig. 7, Plate V., which represents a section through the hæmorrhagic skin of Nurse T. There is in this latter no trace of any change in the epidermis, nothing whatever to suggest that therein a disease was present, one of the essential characters of which is the formation of a vesicle in the stratum malphigii. Similarly there is likewise no indication of any diseased condition of the superficial layer of the corium, such as invariably is the case in hæmorrhagic small-pox. But there is hæmorrhage and effusion of blood in substance extending *into the interfascicular lymph spaces of the deeper layers of the corium.* The difference, therefore, between the condition of the skin in the two cases is the widest possible difference. While the appearances of the one, the hæmorrhagic variola, are very obvious and typical of well understood conditions, those of the other (hæmorrhage in the skin of Nurse T.) are in every detail different. True, it may be said that in the case of Nurse T. there has been no time for the formation of the vesicle, death having taken place

at the beginning of the third day after the first appearance of the rash. But while admitting this, it seems very strange that if this be really a case of hæmorrhagic small-pox there should have been no indication anywhere (I may mention here that sections were made of several pieces of skin exhibiting the hæmorrhagic spots, and always with the same result) of any change whatever in the stratum malphigii or in the superficial corium. From these considerations I think I am justified in saying that the evidence that the case was one of hæmorrhagic small-pox rests almost solely on the clinical symptom of the bathing-drawer like distribution of the hæmorrhagic spots.

Cases of Typical Hæmorrhagic Small-pox.

Case 1.—The figure referred to at page 555 as representing a section of the skin of undoubted hæmorrhagic small-pox relates to a case at Barnet of a female, E. B., æt. 29. Death in this instance took place on the fourth day after the appearance of the rash. At the post-mortem performed a few hours after death a capillary pipette was filled with blood taken directly from the right ventricle and immediately sealed.

From this blood a number (four) of stained film specimens were made. A couple of surface agar plates and a couple of agar tubes were also inoculated each with a good sized drop. Further, two milk tubes each received a couple of drops of blood and were then incubated anaërobically.

The film specimens showed no bacteria of any kind. The agar plates, the agar tubes, as well as the anaërobic milk tubes, all incubated at 37° C., all remained free of any growth. Examination of sections through the eruption showed no bacteria anywhere.

This case is therefore of considerable interest and importance. It was in every way a typical and severe case of hæmorrhagic variola. The vesicular phase was well pronounced, and the sections made through the eruption showed the typical and characteristic micro-pathological features. Nevertheless no bacteria of any kind could be demonstrated either microscopically in film specimens or in the several cultivations made with relatively large amounts of the blood; thus proving that the hæmorrhagic condition probably was not due to the presence of demonstrable microbes—septic or otherwise—in the blood of the generalcirculation.

Case 2.—L. D. C., æt. 40, was another case of hæmorrhagic small-pox, third day of illness. Blood was taken from the finger during life. Stained film specimens showed no bacteria. Cultures of the blood were made on two agar plates and on blood serum set with slanting surface. After incubation at 37° C. for several days only the surface of one of the agar plates showed two colonies of white cocci, evidently accidental air intruders.

So that in this case also of hæmorrhagic small-pox the blood failed to give evidence of the supposed septic bacteria which

Dr. Maurice assumes to be the cause of the hæmorrhagic complication. That this case was one of hæmorrhagic small-pox was proved by its epidemiology; it was a secondary case, *i.e.*, one following a case of confluent variola in the same tenement.

Case 3.—A. B., æt. 36. Case of fatal hæmorrhagic small-pox at the Gore Farm Small-pox Hospital. The patient had been dead three days before the post-mortem was made. Film specimens of heart's blood showed a few diplococci. Culture of this blood made aërobically and anaërobically yielded: (*a*) a streptococcus which formed conglomerate masses in broth, but which was barren of pathogenic action on rodents; and (*b*), an anaërobic microbe which in morphological and cultural respects and in its action on the guinea-pig could not be distinguished from Bacillus enteritidis sporogenes.

It is interesting to add that the blood of another fatal case of hæmorrhagic variola examined by my colleagues Dr. Drysdale and Dr. Scholberg yielded a similar result. They isolated from the heart's blood:—(*a*) a streptococcus not possessed of any pathogenic action on the rodent; and (*b*), an anaërobic bacillus, which, however, had no pathogenic action on the guinea-pig.

Case 4.—A case of typical hæmorrhagic small-pox in an adult at the Gore Farm Small-pox Hospital was admitted on a Sunday night, April 6th, and died the following day. The heart's blood showed no microbes in film specimens. Agar plates and anaërobic glucose broth yielded copious growth of Streptococcus brevis. No pathogenic action on rodents.

Case 5.—Another case of fatal typical hæmorrhagic small-pox at the Gore Farm Small-pox Hospital in an adult was subject to a post-mortem at the same date as case 4. Film specimens of the heart's blood showed no bacteria under the microscope. An agar surface plate showed a few colonies of white cocci, probably air borne. A serum tube culture yielded no growth whatever. The subculture of the white coccus was tested on guinea-pigs and mice with negative result.

Case 6.—A last case was that of a woman, dead of hæmorrhagic small-pox, from whom blood was obtained through Dr. Hamer, of the London County Council. This blood yielded no bacteria in film specimens. On the surface of an agar plate there appeared a few colonies of white cocci, probably air borne. A serum tube remained free of growth. The above cocci were subcultured and their effect tested on guinea-pigs and mice. No result whatever.

As already mentioned, Dr. Drysdale and Dr. Scholberg have informed me that they have in the majority of cases of fatal variola, not hæmorrhagic, obtained cultures of streptococci and of staphylococci from the heart's blood.

In this connexion my best thanks are also due to the Metropolitan Asylums Board and to the medical officer at the Gore Farm Hospital for permission and assistance in acquiring material from fatal cases of small-pox.

APP. B, No. 8.

The Micro-pathology of Hæmorrhagic Small-pox; by Dr. Klein, F.R.S.

It will be apparent from the cases above recorded that not only is there no evidence of pathogenic or other specific microbes being present in the blood of cases of true hæmorrhagic small-pox in any such numbers as to suggest a microbic cause of the hæmorrhagic condition, but that, on the other hand, there occur cases of typical hæmorrhagic small-pox in which the ordinary methods fail to demonstrate the presence of any microbes in the blood, pathogenic or other. It is to be concluded then that the explanation given by Dr. Maurice cannot be the correct one. Nevertheless, although at present the real cause of hæmorrhagic small-pox is not demonstrable, Dr. Maurice may be right in the sense that the cause of the hæmorrhagic condition is perhaps something superadded to the virus of variola, a something which, like certain known blood bacteria (hæmorrhagic septicæmia), is capable of causing by its toxic action angiolysis, *i.e.*, disruptive solution of the wall of the peripheral blood vessels. But however this may be, septic bacteria, which in some cases of ordinary variola, as also of hæmorrhagic variola, are demonstrable by the ordinary methods, cannot be the cause of the hæmorrhagic condition.

On the other hand, the case of the Nurse T., whether hæmorrhagic variola or not, is, I think, highly suggestive that the copious presence of a specific pathogenic microbe in the blood may be one proximate cause of the hæmorrhagic condition, as indeed in some cases of purpura hæmorrhagica pathogenic streptococci have been identified as such a cause. Further enquiry by various methods is needed to show what is the additional agency which in variola causes the hæmorrhagic state.

No. 9.

FURTHER REPORT on the APPLICATION of CARBONIC OXIDE to the DESTRUCTION of RATS on PLAGUE-INFECTED VESSELS*; by DR. JOHN HALDANE, F.R.S.

App. B, No. 9.

Report on the application of Carbonic Oxide to destruction of Rats; by Dr. Haldane, F.R.S.

In accordance with the instructions communicated to me by the Medical officer of the Local Government Board, I have inspected a number of vessels of various types with a view to ascertaining in what way air containing carbonic oxide could best be passed through vessels with a view to destroying plague-infected rats before breaking cargo. In the work of inspection I have had the advantage of the advice and guidance of Captains Wilson, Park, and Rice of the Board of Trade. One of these gentlemen accompanied me on each visit, and their co-operation has been invaluable.

Mode of Passing the Poisonous Air through the Interior of a Vessel.

The case of a cargo steamer may be referred to first, as it is relatively simple. Each vessel is divided into several water-tight compartments by iron bulkheads, and it is, of course, evident that every section must be treated separately. As a rule there are two or more ventilators for each section. These ventilators pass through the upper deck, and one of them is often continued through the decks below to the lowest deck, but if so there are free openings in the shaft just below each deck. At the bottom of the hold there is on each side a sluice-valve, controlled from the deck, by means of which any water present may be allowed to flow through the bulkhead towards the engine room pumps. The opening is usually only 3 to 4 inches in diameter. Sometimes, however, there are, instead of sluice-valves, pipes leading separately from the bottom of each compartment to the engine room pumps. These pipes are of large size, and can be laid open in the engine room or stoke-hold. The pipes for the hand pumps on each side, and the pipe used for sounding, pass from the deck to the bottom of each compartment. The hatchway on the upper deck is secured with tarpaulin, and is thus sufficiently tight to prevent much leakage of air.

To fill the hold with the poisonous air (*see* Fig. 1) it would be necessary to pass the latter in through a pipe introduced into one of the ventilators opening just below the upper deck, the other ventilators being closed. The air of the hold would be allowed to pass out partly into the next compartment, through the sluice-valves, and partly to the open air through the pipes of the hand

* In continuation of Preliminary Report contained in the Report of the Medical Officer of the Local Government Board for 1900–1901, p. 572.

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Report on the application of Carbonic Oxide to destruction of Rats; by Dr. Haldane, F.R.S.

pumps and the sounding pipe. Any water in the holds would, of course, need to be pumped out previously. In order that the hold should fill equally in all parts from above downwards, it is

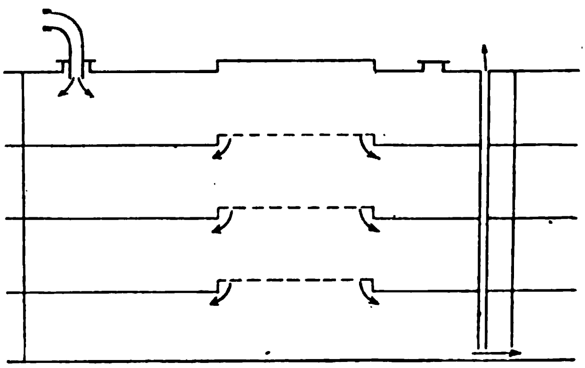

FIG. 1.

necessary that the poisonous air should be distinctly lighter than pure air and for this reason it would be desirable (as suggested in the Preliminary Report) to add in the manner explained below about 10 per cent. of hydrogen to the producer gas employed for making the poisonous mixture. As the size of the openings of the sluice-valves, &c., is small, the process of filling the compartment would be somewhat slow. It would probably not be practicable to drive out through these openings more than from 10,000 to 20,000 cubic feet per hour. In a large vessel there are commonly from 50,000 to 100,000 cubic feet of space in a compartment, and assuming that half this space is completely occupied by cargo, it would be necessary to displace from 25,000 to 50,000 cubic feet of air. Two hours at least would be required for this operation. To ascertain whether the operation was ended it would be necessary to test the air coming up through the sounding pipe from the bottom of the hold. A chemical test could be employed, but the easiest method would be to place a mouse in the air and observe whether it was rendered unconscious within about a minute. As a certain proportion of the air sent in would certainly leak out through the hatch, it would be necessary to drive in more air than could issue through the sluice-valves, &c. Probably 30,000 cubic feet per hour would need to be driven in. Where a ventilator existed, passing down through the decks below (Fig. 2), this could be used as supplementary outlet in filling the upper part of the compartment, a 6-inch hose being dropped down the ventilator, and secured in such a way as to ensure that the outcoming air should come from the lowest accessible part of the hold. This ventilator would be closed as soon as poisonous air began to issue from it. If there were no ventilators at all into the compartment it would be necessary to introduce the poisonous air through a hole cut in the tarpaulin covering the hatchway, after removing one of the hatches.

It is evident that the process would be shortened if it could be arranged to place permanently within the ventilator passing to the lower hold a pipe of about 8 inches diameter, leading down to

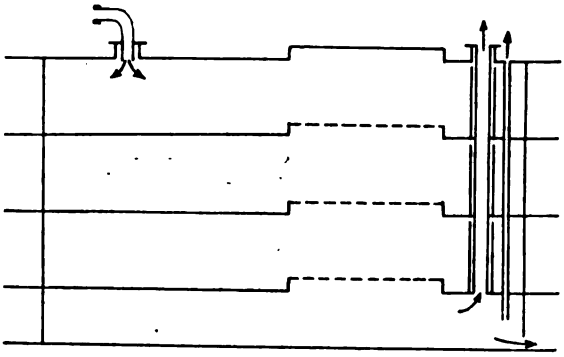

Fig. 2.

the bottom (or even to the top) of the lower hold, and leaving round it a space for the ventilation of the 'tween-decks above (*see* Fig. 3). The provision of a pipe so arranged would, I think,

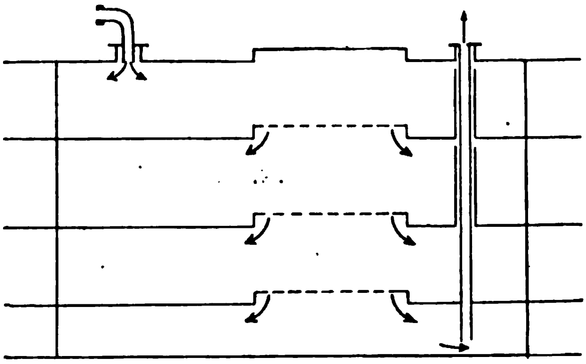

Fig. 3.

entail little expense, and would provide for ventilation, where desirable, of the lower hold.

The process just described would require to be repeated for each of the holds used for carrying cargo, and in order to save time the holds ought as far as possible to be treated simultaneously. Where the sluice-valves to an adjoining hold are used as outlets the latter hold cannot, however, be treated at the same time. Except, therefore, in vessels provided with ventilators to the lower holds the time required for treating all the holds will be at least double that required for treating a single hold.

APP. B, No. 8.

Report on the application of Carbonic Oxide to destruction of Rats; by Dr. Haldane, F.R.S.

The fore-peak, men's quarters, and any other smaller isolated spaces in which rats might be present could be treated by means of a branch air-hose, coming off from the trunk air-hose used for treating the holds. This branch could be led to a ventilator penetrating the upper deck, a separate 6-inch hose introduced through another ventilater or port-hole and passing to the lowest part of the space being used as an outlet (*see* Fig 4).

If it were considered necessary the engine room could be treated by introducing the poisonous air through a main ventilator and allowing the air to escape through the ventilator at the after end of the propeller tunnel, all other openings being closed. The coal bunkers could be treated by passing in poisonous air from a ventilator above and allowing it to pass out through the openings below into the stoke-hold. The stoke-hold itself would be very difficult to treat, as, particularly with the furnaces hot, there would be great difficulty in making this compartment sufficiently tight to fill it with the poisonous air. In a stoke-hold with the furnaces hot, however, there appears to be no space in which rats

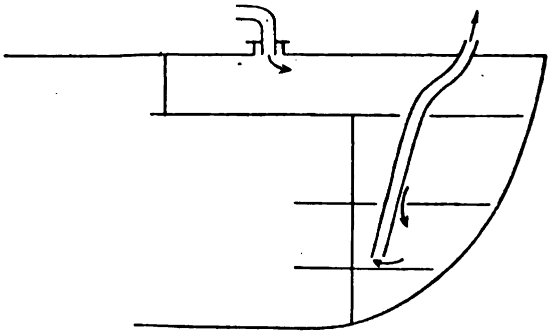

FIG. 4.

could be harboured, and I do not think there would be any necessity for attempting to treat it. So far as I could ascertain there is also very slight chance of rats being present in the engine room or coal bunkers in a vessel coming into port, although they are occasionally seen after they have been driven from the holds when the latter are empty. It would thus probably be unnecessary to treat the engine rooms and coal bunkers.

After the holds had been treated all hatches, ventilators, &c., would be thrown open, and the poisonous air, being lighter than ordinary air, would quickly escape. Before the men were allowed to go below the air could be tested by taking in a small bird and observing whether it showed any sign of discomfort. It could be safely carried in, as it would show signs of the action of carbonic oxide in a fraction of the time necessary in the case of a man.

If the poisonous air from an adjoining hold were allowed to escape into the engine room or stoke-hold it would not be safe for

men to remain in them, and anyone temporarily descending would require to carry a small bird or a mouse to give warning of the presence of poisonous air, although, considering the ample means of ventilation, it does not seem likely that the air would become actually poisonous.

The case of a passenger vessel is more complicated than that of a cargo vessel, but the principle on which it could be dealt with is exactly the same. In many vessels the passenger accommodation above each water-tight section could be treated along with the hold below, there being doors and hatches which could be closed and opened so as to separate the cabins, &c., from the rest of the accommodation forward or aft and put them into free communication with the hold below. In such cases the whole of each section, including passenger accommodation, could be filled at one operation from a ventilator or port-hole above, the air being allowed to pass out below. One of the ventilating shafts passing down through the passenger accommodation into the hold could be used as an outlet until the upper part of the section was filled, the sluice, valves, &c., being the outlets for filling the lower part. In other vessels there are in the passenger accommodation no bulkheads or doors corresponding to the water-tight bulkheads below. In such a case the saloon accommodation could be treated as a separate long section of the vessel and filled with poisonous air from above through a ventilator or port-hole at the highest point, the outlet or outlets being at the lowest convenient point, into which, if necessary, one or more 6-inch hoses could be introduced to conduct the air to the outside through a port-hole or ventilator.

Another complication is introduced by the fact that in many cases parts of the holds are insulated for purposes of cold storage, and consequently closed almost air-tight with no means of ventilation. Where this is the case the poisonous air cannot be passed through. I am informed, however, that no rats are present in the cold chambers, in which case it would not in any case be necessary to treat the insulated parts.

In the event of an empty vessel requiring to be freed of rats there would be no difficulty in simultaneously treating all the compartments, as a free outlet from the bottom of each hold could easily be provided by dropping a length of hose down through a ventilator or through a hatchway.

A sailing ship not divided into compartments and with no ventilating shaft passing to the bottom could not, of course, be treated in the same way as a steamer. In most large sailing vessels, however, it is possible to get at the bottom either through manholes beside the pumps or through the chain-lockers forward. It would in this case be easy to drop one or more air hoses to the bottom of the vessel to serve as outlets, the poisonous air being blown in through ventilators or hatches. Where it was not possible to get at the bottom the pipes of the pumps on each side could be utilised as inlets after the pump-wells had been emptied as far as possible. In such a case it would take a much longer time to fill the whole vessel with poisonous air, as the incoming

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air would mix to a much greater extent with the air originally present. The pipes of the pumps, which are about 4 to 6 inches in diameter, probably could not be used as outlets, as their lower ends would be covered with the water in the wells; but it might be found practicable to remove enough of this water to free the lower end of the pipe by lowering a length of narrow stiff-walled flexible tubing and sucking up the water by means of a portable exhausting pump. Failing the pipes of the pumps it would be necessary to clear a way to the bottom by removing part of the cargo by means of lighters or in any other way which would diminish to a minimum the risk of rats getting ashore.

Arrangement for Distributing the Poisonous Air.

The poisonous air could, I think, be most conveniently carried from the barge containing the carbonic oxide plant to the holds by means of three separate lengths of flexible air-tight hose of about 6 inches internal diameter. This could be stored at the sides of the barge in lengths of 20 and 10 feet, and could be handled without difficulty. One hose could be taken aft and one forward, while the third could be used near the centre of the vessel, where the barge itself would be moored. Each hose would probably be capable of delivering about 50,000 cubic feet per hour without using undue pressure. About 300 feet of this hose would be needed. In addition about 100 feet of 4-inch hose would be required for taking branch currents.

To introduce the gas down a ventilator the cowl would first be removed. A galvanised iron pipe 6-inches in diameter, bent round at a right angle, and provided with a flange 2½ feet wide, as shown in Fig. 5, could then be set in the ventilator and kept in

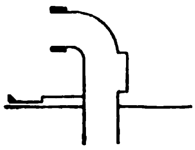

FIG. 5.

position by means of weights on the flange. It should be provided with a simple slide valve for regulating the amount of air passing down, and with an extra connexion (furnished with a cap) for a 4-inch branch hose. The same arrangement could be used for introducing the gas through a hole in the tarpaulin covering a hatch. In introducing the air through a port-hole the simplest way of rendering the opening tight round the hose would probably be to use wet sail-cloth or similar material as stuffing. When a length of hose had to be dropped down a ventilator it could be passed through a circular hole in the centre of a plate covering the ventilator.

Size and Arrangement of Apparatus for Producing the Poisonous Air.

In the preliminary report a description has already been given of the nature of the plant proposed for making a suitable mixture of carbonic oxide and air. It only remains to refer to the capacity of the apparatus and certain details of arrangement.

Fig. 6 is a rough plan of the proposed arrangement of the apparatus on a barge having a clear floor space of 10 by 35 feet. It will be seen that the two exhausters are so coupled that the smaller one is driven from a pulley on the axis of the larger one. This arrangement prevents all chance of an explosive mixture being by any mistake of the engineer driven into a vessel even temporarily. By varying the size of pulley on the small exhauster it is possible to adjust accurately the proportions of producer gas to air. The two air coolers through which the producer gas passes after leaving the generator are of the pattern used by the Dowson Company. After leaving the coolers the gas passes through a coke

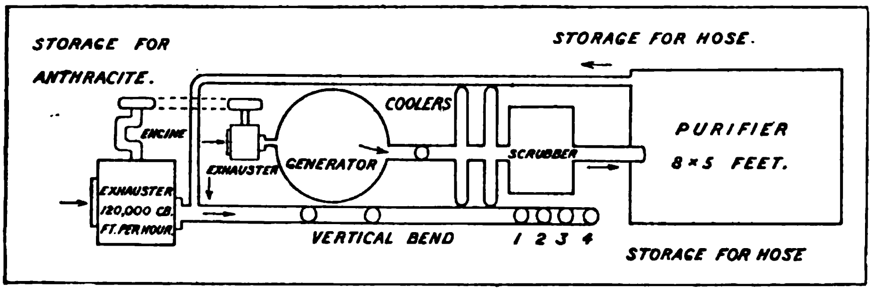

Fig. 6.

scrubber, the object of which is to remove as much as possible of the smoke from the gas, and thus prevent the purifier from being rapidly choked by the particles of smoke. To reduce to a minimum the formation of smoke in the generator anthracite should be used instead of coke. The purifier itself is described in the preliminary report. The lid is bolted on in two sections, so that it can easily be moved by hand. The top is above the level of the sides of the barge, so that the ends of the rakes can project freely. To ensure a thorough mixture of the air and gas the main pipe is given a vertical bend up and down at the point shown. The mixture is driven off through the lengths of 6-inch hose at the openings 1, 2, and 3, which are provided with slide-valves. The opening No. 4 leads to an escape pipe, and has a valve so weighted as to allow any excess of the mixture to pass out when the pressure exceeds about 4 inches of water. If all the slide-valves are closed the whole of the mixture will pass out through this valve. The apparatus is provided with pressure gauges at different places, and with gauges for indicating the velocity of flow of both the producer gas and the mixture, so that the engineer can ascertain what the proportions are. The internal

diameter of the pipe for the producer gas is 2 inches, and that for the mixture 9 inches, so that the proportion of producer gas will be right when the velocities in the two pipes are equal.

It is probable that, considering the restricted outlets to the holds, it would not usually be feasible to deliver as much as 100,000 cubic feet per hour of the mixture. The exhausters ought, however, to be capable of delivering 120,000 cubic feet, as in some cases this amount could be driven in. Assuming that 120,000 cubic feet per hour were delivered against a pressure of four inches of water (which would be quite sufficient), the work done on the air per minute would, since one inch of water gauge equal a pressure of 5·4 lbs. per square foot of surface, be = 2,000 × 4 × 5·4 = 43,200 foot pounds, or 1·3 horse power. It is evident, therefore, that the power required for running the exhausters would be small. An oil engine would probably be most convenient for driving them.

As already explained, above, it would be desirable to add to the air entering the generator enough of steam to raise the proportion of hydrogen in the producer gas to about 10 per cent., in order to make the mixture distinctly lighter than air. For this purpose a suitably adjusted steam jet air-injector might be employed, as in the case of the Dowson gas producing plant, an excess of the required mixture of air and steam being blown past the inlet of the small exhauster, as shown in Fig. 7. The percentage of steam

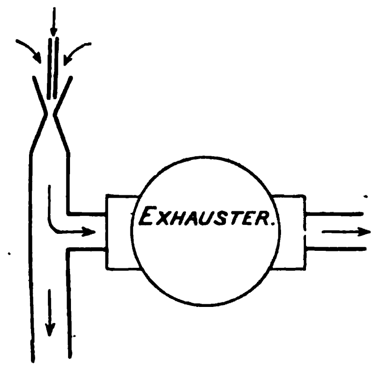

Fig. 7.

would thus remain sufficiently constant at whatever rate the exhauster was working. The presence of the hydrogen would slightly increase the percentage of combustible gas in the mixture, and for this reason it would be best to arrange the deliveries of the two exhausters so that the mixture should contain only 5 per cent. of producer gas, corresponding to 1·25 per cent. of carbonic oxide and 0·5 per cent. of hydrogen. This would allow an ample margin of safety, as only about a sixth of the percentage needed to form an inflammable mixture would be present, and the apparatus is so designed that this proportion could not be exceeded. The steam could be supplied from a small boiler placed beside the generator.

Whether the plan of killing plague-infected rats by means of carbonic oxide would turn out to be feasible and convenient can only, I think, be decided by actual experiment. One practical difficulty arises from the fact that the apparatus might be seldom required, and would yet have to be always kept in readiness. Were it, however, employed, when desired by shipowners, for the purpose of clearing ordinary vessels of rats, the difficulty would be greatly diminished.

The description and diagram given above are only intended to indicate the general plan of the apparatus. The working out of details, with a view to rendering the plant as compact as possible, and the preparations of working plans would require to be carried out by a professional engineer. If a trial apparatus was decided on it might well be made of about half the capacity suggested above, and with only one 6-inch hose passing to the vessel.

In visiting the docks I had an opportunity of watching the process of freeing an empty vessel of rats by the Clayton process of blowing in sulphur dioxide, produced by the burning of sulphur in a special apparatus. This plan has the advantage that the gas being heavier than air it is easy to fill the holds without closing them above. It would appear that a small percentage only of the gas is needed to kill the rats, and as it has a most pungent smell there is no risk of men being accidentally affected. Sulphur dioxide can also be applied to empty vessels by the old plan of burning sulphur in the holds, &c., or by liberating liquid sulphur dioxide stored in metal vessels. So far as I could ascertain the rats were in the particular instance effectually destroyed by the Clayton treatment, and, except for some superficial tarnishing of metal work in the engine room, no appreciable damage was done, even in the first-class saloons, by the gas. The only precautions taken was to see that everything was dry: fabrics, or articles of cargo, which are moist—for instance fruit—are, it would seem, easily damaged.

APPENDIX C.

No. 1.

App. C, No. 1.

Equine Variola; by Dr. Blaxall.

Report on Equine Variola; by Dr. Frank R. Blaxall.

In the "Lancet" of the 6th July, 1901, appeared a letter from Mr. Ernest Crompton, M.R.C.S., of Newmarket, stating that he had recently seen five or six cases of stable lads inoculated with this disease from the horse. I therefore asked him if he met with other cases in horses to be good enough to send me some of the pathogenic material.

In February, 1902, Mr. Crompton sent me some "lymph" which he had obtained from a horse.

This material was inoculated on a calf in the usual way. After five days the inoculated area was inspected, and there were seen to be only a few small isolated vesicles in the lines of incision. The vesicles were very small and felt somewhat "shotty." They were scraped off and rubbed up with glycerine, and a week later this material was used for the inoculation of another calf. Here after 120 hours the inoculated surface showed lines of continuous vesicles exactly resembling those met with in ordinary vaccinia. This material was in turn collected and glycerinated in the usual way, and four months later was used for the inoculation of other calves. On one of these the vesicles developed in ideal fashion, having a beautiful pearly aspect and being quite continuous.

Previous to my obtaining the above satisfactory results, Mr. Crompton had sent me some more lymph from a horse affected with equine variola, saying that: "I find it very difficult to get any lymph from the vesicles; I have scraped them with a Volkmann's spoon and macerated the scrapings in a little sterile water. . . . . The horses have been two-year-old thoroughbreds, and it is difficult to get at them. . . . . The disease has been prevalent here for some years, and I imagine the horses are infected from previous cases and not from the human."

This additional equine material when inoculated on to a calf developed in the same way as the first sample, about five tiny vesicles resulting. These glycerinated and transferred to other calves produced vesicles of precisely the same character and appearance as those usually obtained from calf lymph.

Subsequently one of the calves vaccinated with lymph from an equine variolous source, which had developed good vesicles, was kept for 10 days after collection of the vesicular pulp and was then re-vaccinated on fresh areas with ordinary calf lymph. No vesiculation resulted; showing that the protection afforded this animal by lymph from the equine variolous stock was complete

against lymph from the calf stock. I also vaccinated myself with lymph derived from the horse, knowing myself to be quite protected against ordinary vaccinia. No reaction followed the inoculation.

Mr. Crompton also sent me on two occasions lymph obtained from vesicles on stable lads inoculated direct from horses. He says: "I have recently revaccinated over 100 lads (with ordinary calf lymph), but have not got all the results, but I believe every one has taken in four places, except some half-dozen all of whom have suffered from equine variola from one to six years ago; in none of these cases was there any reaction to vaccine, so that it seems to be the same thing."

These lymphs from the stable lads when inoculated on calves produced typical vaccine vesicles of ordinary character and size, differing in this respect from those obtained on the calf from horse vesicles direct. Thus it appears that equine variola produces vesicles more readily on the human subject than on the calf. It seems to require two removes on the calf before the vesicles attain to the ordinary vaccine type. This affords another illustration that the human subject is more susceptible to vaccinia than the calf.

With regard to the appearance of the disease in the horse, Mr. Crompton says: "As far as I can make out there are no proper vesicles, the eruption remaining papular. I have cut into several, very little serum exudes and they do not collapse. The eruption in the horse is chiefly limited to the mucous surfaces. . . . ."

With regard to the direct inoculation of the human subject from the horse, he says: " . . . . there has been considerable pain, and the lymphatics have been enlarged in axilla, and lymphatic vessels have been seen running up the arm. This has been the case in all cases I have seen."

The most noteworthy points about this strain of equine variolous lymph appear to be:—*First*, the difference in the results produced on the calf by the inoculation of material direct from the horse and by the inoculation of the material after passage through the human subject. The material from the horse direct does not produce typical vesicles at first, but only a few small vesicles. These, however, glycerinated, and transferred to other calves, are capable of producing typical and perfect vesiculation. The human material, on the other hand, produces on the calf at once vesicles of the ordinary type, but so far in my hands not of first-rate quality. *Secondly*, Mr. Crompton's remarks show that the inoculation with equine variolous lymph gives complete immunity against ordinary vaccinia, the protection lasting for a considerable time. This point is borne out by the negative results obtained by revaccinating the calf and myself.

No. 2.

App. C, No. 2

A Method of Anaërobic Culture; by Mr. Fremlin.

Report on a Method of Anaërobic Culture; by Mr. H. S. Fremlin.

By the use of hydrogen it is no doubt possible to obtain anaërobic conditions suitable for the growth of anaërobic micro-organisms.* Nevertheless this method requires a good deal of apparatus, is tedious, and the results are, owing to defects in the process, often unsatisfactory. I have, therefore, for some time past tried to find a method simpler and more constant in result.

Alkaline pyrogallic solution on the other hand has proved itself in a Buchner tube a thoroughly efficient means of obtaining anaërobic conditions for test tube cultivations, though for anaërobic culture in Petri dishes this method was not uniformly satisfactory. Employment of Botkin's apparatus, Bullock's modification, and that adopted by Dr. Klein, and described by him in the Report of the Medical Officer, 1897–98, on p. 219, and apparatus of other investigators proved, in my hands, after many experiments to be somewhat unreliable. I found that if the apparatus contained a large air space, the vacuum created by the absorption of oxygen by pyrogallic solution frequently tended to render the seal, as ordinarily used, inefficient. Thus with these methods I found that plate culture of such a strict anaërobic organism as B. Tetani frequently failed. But being assured, however, that alkaline pyrogallic solution is capable of absorbing oxygen not only in large amount, but also in a slow and continuous fashion, I again turned my attention to its use in plate culture, conceiving that good results might be obtained if the plate, together with the pyrogallic solution, were confined in a space holding but little air, so that the contained oxygen of the air and that of the culture medium might be well within the limits of the absorptive power of the solution, and the seal be of such a nature that a vacuum when created could be maintained.

For this purpose I have devised a simple apparatus which has given most satisfactory results. It consists of a shallow circular glass chamber with a lid. The chamber, which is just large enough to contain an ordinary $3\frac{1}{2}$-inch Petri dish, measures five inches in diameter and is one inch in depth; and the rim is turned out in a wide flange carefully ground. The lid is perfectly flat and is ground at the margin, so that

* Report of Medical Officer, 1900–1901, Appendix C.

App. C, No. 2. A Method of Anaërobic Culture; by Mr. Fremlin.

when in position the two ground surfaces are in accurate apposition. Within the chamber is placed an ordinary 3½-inch Petri dish containing the inoculated medium, from which the lid is removed when the chamber is about to be closed. It is, however, an advantage to place this inoculated plate within another glass dish, such as the lid of a Petri dish, in order to prevent any splashing of the culture medium, or discolouration of the dish containing it, by the pyrogallic solution.

At first I thought it would be necessary to heat the whole apparatus to keep the culture medium liquid for a time, as seems essential in the employment of hydrogen. But I find that this is quite unnecessary; that the pyrogallic solution is capable of abstracting the oxygen from air contained in the chamber and culture medium, indeed, even after the medium has already set and thus contains the oxygen which it had re-absorbed whilst being poured into the dish. Further, I find that the absorptive power of the solution is not quickly exhausted, that it may continue for some time. For example, the chamber being opened and the plate removed for examination, the medium will during this exposure re-absorb oxygen. Nevertheless, if meanwhile the chamber has been carefully closed, the same pyrogallic solution can still continue to act, and anaërobic conditions can again be established in the plate if it be re-inserted.

That this is so was shown by the application of two tests.

The first was that B. tetani grew freely and constantly when inoculated into sugar agar plates and placed in the apparatus.

The second was equally delicate: Here I mixed with the culture medium an indicator extremely responsive to the presence of oxygen. This indicator is methylene blue as advocated by Hammerl.*

The method of using the apparatus is as follows. A tube of ordinary culture medium, such as agar or gelatine, is liquefied, inoculated, and poured into a Petri dish. This plate is then placed in the chamber; and, as already advised, it is better to put it into the half dish, which should be already in position in the chamber. Pyrogallic acid, in solution, is then poured into the chamber between its inner wall and the outer dish, and the lid of the chamber, previously well vaselined along the ground margin, is slid on, covering the plate save for a small aperture on one side. Through this aperture the solution of caustic potash is poured into the pyrogallic acid solution. The lid is then slid into such a position that it completely covers the interior of the chamber and excludes all air.

The apparatus is now ready to be placed in an incubator.

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* Zur Züchtung der Anaëroben; Centralbl. f. Bakteriol., &c. No. 12, 1902.

App. C, No. 2.

A Method of Anaërobic Culture; by Mr. Fremlin.

In about 24 hours, at 37° C., the anaërobic conditions are complete, and in such conditions B. tetani can be readily cultivated.

I find that 1 gramme of pyrogallic acid and 10 c.c. of a 10 per cent. solution of caustic potash give satisfactory results.

It cannot be too strongly emphasised that although the absorptive action of alkaline pyrogallic solution on oxygen commences immediately, yet, it requires several hours before every trace of oxygen is taken up.

If methylene blue be used as an indicator (and some micro-organisms, such as B. tetani show no objection to its presence, though the staphylococci do most markedly), about four drops of an alcoholic solution are required for every 100 c.c. of culture medium. This suffices to give each tube of culture medium a good blue colour. Such a tube is liquefied, inoculated, and poured into a Petri dish in the usual way. If the anaërobic conditions are made complete the culture medium in the dish, which was blue, becomes wholly decolourised; but if free oxygen has been left in the chamber, or if there has been in any way entrance of air, the blue colour remains unaltered. This action is quite apart from the decolourisation of methylene blue resulting from bacterial activity, since it occurs in sterile media.

The reaction is accelerated by heat, perfect decolourisation occurring in 24 hours at 37° C.; but it also obtains quite well in the cold, although 48 hours or possibly more may be required.

Exactly the same action may be seen if culture media coloured blue are used in Buchner tubes. Here, however, care is required; for it not unfrequently happens that the culture tube falls into the constricted opening at the lower part of the Buchner tube, completely shutting off the lower chamber, which contains the pyrogallic solution, and thus prevents this solution from exerting its power on the upper part of the tube which contains the culture. This source of fallacy can easily be obviated by doing away with the constriction and using a large tube with a simple support for keeping the culture tube out of the pyrogallic solution.

With regard to the use of methylene blue as an indicator some care is required. There appear to be three factors requisite for the reaction to take place. These are: (1) the presence of some reducing body in the culture medium; (2) the presence of an alkali; (3) the absence of a free supply of oxygen.

(1.) The reducing action is markedly present in glucose, lactose, and maltose, but not in cane sugar; it is present in crude agar, to a less extent in crude gelatine, and shows itself but very feebly in beef broth, hardly at all in peptone

water, and is entirely absent in tap water or in water made alkaline.

(2.) No reaction is obtained in any instance unless the reducing body is in the presence of an alkali. For instance, a 2 per cent. glucose solution shows no reducing power whatever until an alkali is added. The small quantity of alkali that is added to culture media and which is naturally present in blood serum, is quite sufficient to allow the reducing action to take place; but in every case the action is intensified by an increase in the amount of alkali, so much so that ordinary beef broth which is faintly alkaline, can barely decolourise one drop of an alcoholic methylene blue solution in 100 c.c., whereas addition of an excess of alkali, such as caustic potash or soda, allows of the decolourisation of 1 c.c. or more of the alcoholic methylene blue solution.

Mention must be made here of the fact that all media that have been prepared for the cultivation of bacteria lose slowly, steadily, and progressively the faintly alkaline reaction that they possess when freshly prepared. For instance, a given quantity of medium freshly made requires 1 c.c. of an alkaline solution to give an alkaline reaction to phenol phthaleine.

This same amount of medium after—

1 week will require	2 c.c.
2 weeks „	3 c.c.
5 weeks „	4 or 5 c.c.

to obtain the same result.

This gradual loss of alkalinity has an important bearing on the use of methylene blue and also of course on the growth of bacteria. It has been brought prominently before my notice in connection with these anaërobic experiments.

(3.) Thirdly, some means must be used to shut out the surrounding oxygen of the air. That this is necessary is seen from a simple experiment. If a tube of culture medium coloured blue with the methylene blue be placed in a beaker of water and the water boiled, as the medium liquefies and as air is driven out, the blue colour gradually disappears till it is has been entirely removed. But on cooling the tube the blue colour reappears at the surface where the culture medium is in contact with air, and in the course of two or three days extends some way into the medium; so that the upper one-third or one-half of the nutrient substance in the tube shows this evidence of the presence of oxygen, the lower portion retaining the ordinary colour of the medium, so that when the oxygen has been absorbed from the culture medium means must be taken to hermetically seal the vessel and so prevent re-absorption.

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In this connection I find that plugging of tubes tightly with wood, the capping of them with tightly fitting india rubber caps, or with gutta-percha tissue proved to be quite an inefficient seal against the absorption of oxygen by pyrogallic solution. Indeed even corks well paraffined were frequently equally useless.

After the methylene blue medium has been decolourised by boiling the colour at once returns if the vessel or tube containing it be shaken in the air. In this connection it is interesting to note that any fluid which has been deprived of air will re-absorb it if merely poured from one vessel into another. In fact by so pouring, half the amount of air that it is capable of absorbing is taken up. This fact must be remembered when plates are poured for culture of anaërobic bacteria. After the medium has been boiled for 10 minutes it is entirely deprived of oxygen, as shown by the methylene blue test. But if now this culture medium be poured into a Petri dish gas is again absorbed. Therefore further extraction of oxygen is required for anaërobic conditions to obtain.

No. 3.

Further REPORT on the action of CHLOROFORM and various other substances on the SPECIFIC and EXTRANEOUS MICRO-ORGANISMS of VACCINE; by DR. ALAN B. GREEN.

Plates XVII.—XXI.; Figures 1—10).

An account of the first experiments made by me on this subject, appeared in a paper published in the Report of the Medical Officer to the Local Government Board, 1900–1901. The present paper deals with the continuation of those experiments.

The object throughout has been to ascertain, as far as possible, the relative resistances of the specific and the extraneous micro-organisms contained in freshly collected vaccine to various chemical substances, and to compare such resistances with the resistance of similar germs to glycerine.

As mentioned in my former paper, the results of the action of glycerine on vaccine material are fairly well defined. Generally speaking its action is germicidal to the non-sporing adventitious bacteria of crude vaccine in from 4–8 weeks, the specific organism remaining meanwhile resistant to this destructive action, and continuing potent for considerable periods of time. As in the case of the specific organism, spore-bearing organisms also show considerable powers of resistance. These spore-bearing organisms, which occur occasionally in vaccine, are practically confined to the mesenteric group of bacteria. Indeed, in the thousands of vaccines examined at these laboratories no other variety of spore-bearing bacteria has been found.

While much investigation has been made of the action of glycerine on vaccine, apparently little is known concerning the action on vaccine of other chemical substances, and glycerine appears to be, at the present time, the only agent in vogue for the "purification" of vaccine. That this property was not peculiar to glycerine, but was possessed by other substances, was shown last year in the paper already referred to.

The present experiments were begun in July, 1901; they are 240 in number, and deal with 32 chemical substances.

Looking at the results of the first series of experiments it seemed probable that observations on the action of substances chemically allied to glycerine—the alcohols—and of some glycerine and other alcoholic derivatives, might be of interest.

Some of these substances, as well as others of a more general nature, have since been tested, and, lastly, the action of chloroform has been further studied in several experiments.

It may be convenient, before entering into details of the results of these experiments, to give as briefly as possible a description of the method used, as it differs in some slight respects from that of my former experiments on this subject. This method does not refer to the action of chloroform on vaccine, which is dealt with later.

Procedure in the case of Non-Volatile substances.

A.—*Preparation.*

1. Vaccine was collected from calves in the usual aseptic way, 120 hours after vaccination.

2. This material was finely ground up in a triturating machine.

3. This ground up vaccine was divided into weighed quantities of a gramme each. Each gramme of vaccine was mixed, by means of a sterilised pestle and mortar, with four times its own weight of a solution of experimental substance. In each experiment, to serve as a control, one gramme of vaccine was mixed with four times its own weight of a sterilised 50 per cent. solution of pure glycerine and distilled water.

4. All solid and some fluid experimental substances were used in known strength of solution in distilled water. These solutions were not sterilised, it being desired in order that any micro-organisms capable of growth in them might be observed.

5. Each vaccine, experimental or control, when intimately mixed with its requisite quantity of solution, was poured into sterilised glass "stock" tubes, resembling small test tubes. A sterile cork was then firmly inserted into the mouth of each tube in such a way that the top of the column of fluid and the bottom of the cork were in contact, with the intention of excluding air as far as possible. The corked end of each tube was then sealed with melted paraffin.

6. After mixture all vaccines were left in a dark cupboard, at room temperature, and were only temporarily removed when required for testing purposes.

B.—*Examination for Extraneous Micro-organisms.*

1. The number of extraneous micro-organisms present in a platinum loopful of each vaccine control, immediately after mixture with the glycerine solution, was ascertained by means of nutrient agar-agar plate cultures incubated for 48 hours at 37° C., and for 72 hours further at room temperature. The number of extraneous micro-organisms present in a loopful of the control vaccines at the time of mixing was considered to be equivalent to the number originally present in a loopful of the experimental vaccines, before any germicidal or other influence of an experimental substance had made that influence felt. The same platinum loop was used throughout the experiments, and in every case one loopful of vaccine was the quantity used in testing vaccine for micro-organisms, except in a few cases expressly stated later, where a capillary tubeful of vaccine was so used.

2. Similar plate cultures were made from experimental and control vaccines, 24 hours after mixture, and at the end of the 1st, 4th, and 7th weeks after mixture.

All cultures were made aerobically. No anaerobic cultivations were made, owing to the fact that Mr. H. S. Fremlin has found that no extraneous micro-organisms of vaccine are capable of growth anaerobically that can not be grown equally well aerobically.*

Dr. Blaxall has urged the necessity of using a small measured quantity of vaccine for the inoculation of each agar-agar plate; for, owing to the variations in viscidity of vaccines, where some are mixed with a watery solution, some with a viscid solution, and control vaccines with a solution of the viscidity of a 50 per cent. mixture of glycerine in distilled water, it is inevitable that loopfuls of these vaccines are not equal quantities even when the same loop is used. Variations in quantity occur in loopfuls of vaccines mixed with a 50 per cent. mixture of glycerine and distilled water, owing partly to the variable quantity of liquid present in the vesicular material at the time of collection from calves, and partly also, perhaps, to variations in the coagulable material present.

Pressure of work during the past year has, however, precluded my examining vaccines for extraneous organisms other than by using loopfuls, except in the case of some chloroform vaccines.

Although these methods may not have been mintely exact, they have been so exact as to give unmistakable results, and in the case where valuable "selective" germicidal action has been shown, it is hoped in the future to repeat the experiment by some method which will show the most minute differences.

C.—*Examination for Potency.*

The potency of each experimental vaccine and its control was tested by inoculating calves in the routine way as opportunity offered; and this was of necessity at irregular intervals, the considerable number of experiments rendering a uniform method of procedure impossible. In the Tables which appear in this paper the latest time of testing each vaccine is noted. This does not by any means indicate the limit of potency except where such limit be expressly stated, but merely the latest date of testing.

Volatile Substances.

In the case of solutions of volatile substances, the only modifications of the above-mentioned procedure was:—

(*a.*) Instead of using weighed quantities of solutions required for admixture with vaccine, the equivalent volume of a certain known weight of the solution was determined; this volume or a multiple of it could at any time be easily and rapidly measured in a pipette.

* *On the Influence of Anaerobic Conditions on the Extraneous Organisms of Glycerinated Calf Lymph.* By Mr. H. S. Fremlin, in the Report of the Medical Officer, Local Government Board, 1900–1901.

(*b.*) The weighed quantity of vaccine which had already been ground up in the machine was intimately mixed, by means of a sterilised pestle and mortar, with half the required amount of solution. This mixture was poured into a stock tube, after which the remaining half of the amount of solution was rapidly added, and the stock tube was immediately corked and sealed. The resulting mixture, therefore, contained the volatile substance in rather less quantity than did the original solution used, owing to the first portion of fluid having been exposed in the mortar.

(*c.*) Each tube was agitated for a few minutes until the contents appeared to be intimately mixed.

For convenience of reference and comparison, the various substances used in these experiments have been grouped as follows:—

CLASS A.—*Some Alcohols.*

CLASS B.—*Some Alcohol Derivatives and Allied Substances.*

CLASS C.—*Various Other Substances.*

CLASS D.—*Chloroform.*

CLASS A.—*Some Alcohols.*

The reason why this series of experiments was made was primarily owing to the fact that glycerine is an alcohol. It promised to be of interest to know something of the action on vaccine of other substances of the same class chemically as glycerine.

Accordingly selection was made of one or more alcohols, obtainable commercially, from each alcoholic group, and experiments were begun by mixing these substances either in their pure state, or in various strengths of solution in distilled water, with vesicular material. Altogether 80 experiments have been so made. Of the alcohols of the first group—the monatomic alcohols—four members have been used, namely, methyl alcohol, ethyl alcohol, isobutyl alcohol, and amyl alcohol. Of the alcohols of the second group—the diatomic alcohols—one was used, namely, glycol. Glycerine itself belongs to the triatomic group, and no other member of this group was obtainable. Of the tetratomic alcohols two have been used, erythrite and pentaerythrite. No pentatomic alcohol was obtainable, and but one hexatomic alcohol—mannite. Details of these experiments are noted in Table A.

Methyl Alcohol, CH_3OH.—Sixteen experiments have been made with aqueous solutions of this alcohol, varying in strength from 0·5 per cent. to 30 per cent. In each of the first nine experiments, in which solutions containing 0·5 per cent. to 10 per cent. of the alcohol were used, the extraneous micro-organisms either increased in number or there was a decrease so slight as to be practicably negligible. With the use of the 15 per cent. solution

	Potency.		
At nd of	Experi- ment.	Control.	Number of Experiment.
month	+	+	1
month	+	+	2
month	+	+	3
month	+	+	4
month	+	+	5
month	+	+	6
month	+	+	7
month	+	+	8
month	+	+	9
month	+	+	10
week	?	+	11
week	-	+	12
week	?	+	13
week	-	+	14
week	-	+	15
week	-	+	16
weeks	+	+	17
weeks	+	+	18
weeks	-	+	19
onth	+	+	20
onth	+	+	21
onth	+	+	22
eek	+	+	23
eek	+	+	24
eek	+	+	25
eek	+	+	26
eek	+	+	27
eek	+	+	28
onth	+	+	29
onth	+	+	30
onth	+	+	31
onth	+	+	32
onth	+	+	33
onth	+	+	34
onth	+	+	35
onth	+	+	36
eek	+	+	37
eek	+	+	38

[*Continued.*

Procedure in the case of Non-Volatile substances.

A.—*Preparation.*

1. Vaccine was collected from calves in the usual aseptic way, 120 hours after vaccination.

2. This material was finely ground up in a triturating machine.

3. This ground up vaccine was divided into weighed quantities of a gramme each. Each gramme of vaccine was mixed, by means of a sterilised pestle and mortar, with four times its own weight of a solution of experimental substance. In each experiment, to serve as a control, one gramme of vaccine was mixed with four times its own weight of a sterilised 50 per cent. solution of pure glycerine and distilled water.

4. All solid and some fluid experimental substances were used in known strength of solution in distilled water. These solutions were not sterilised, it being desired in order that any micro-organisms capable of growth in them might be observed.

5. Each vaccine, experimental or control, when intimately mixed with its requisite quantity of solution, was poured into sterilised glass "stock" tubes, resembling small test tubes. A sterile cork was then firmly inserted into the mouth of each tube in such a way that the top of the column of fluid and the bottom of the cork were in contact, with the intention of excluding air as far as possible. The corked end of each tube was then sealed with melted paraffin.

6. After mixture all vaccines were left in a dark cupboard, at room temperature, and were only temporarily removed when required for testing purposes.

B.—*Examination for Extraneous Micro-organisms.*

1. The number of extraneous micro-organisms present in a platinum loopful of each vaccine control, immediately after mixture with the glycerine solution, was ascertained by means of nutrient agar-agar plate cultures incubated for 48 hours at 37° C., and for 72 hours further at room temperature. The number of extraneous micro-organisms present in a loopful of the control vaccines at the time of mixing was considered to be equivalent to the number originally present in a loopful of the experimental vaccines, before any germicidal or other influence of an experimental substance had made that influence felt. The same platinum loop was used throughout the experiments, and in every case one loopful of vaccine was the quantity used in testing vaccine for micro-organisms, except in a few cases expressly stated later, where a capillary tubeful of vaccine was so used.

2. Similar plate cultures were made from experimental and control vaccines, 24 hours after mixture, and at the end of the 1st, 4th, and 7th weeks after mixture.

All cultures were made aerobically. No anaerobic cultivations were made, owing to the fact that Mr. H. S. Fremlin has found that no extraneous micro-organisms of vaccine are capable of growth anaerobically that can not be grown equally well aerobically.*

Dr. Blaxall has urged the necessity of using a small measured quantity of vaccine for the inoculation of each agar-agar plate; for, owing to the variations in viscidity of vaccines, where some are mixed with a watery solution, some with a viscid solution, and control vaccines with a solution of the viscidity of a 50 per cent. mixture of glycerine in distilled water, it is inevitable that loopfuls of these vaccines are not equal quantities even when the same loop is used. Variations in quantity occur in loopfuls of vaccines mixed with a 50 per cent. mixture of glycerine and distilled water, owing partly to the variable quantity of liquid present in the vesicular material at the time of collection from calves, and partly also, perhaps, to variations in the coagulable material present.

Pressure of work during the past year has, however, precluded my examining vaccines for extraneous organisms other than by using loopfuls, except in the case of some chloroform vaccines.

Although these methods may not have been mintely exact, they have been so exact as to give unmistakable results, and in the case where valuable "selective" germicidal action has been shown, it is hoped in the future to repeat the experiment by some method which will show the most minute differences.

C.—*Examination for Potency.*

The potency of each experimental vaccine and its control was tested by inoculating calves in the routine way as opportunity offered; and this was of necessity at irregular intervals, the considerable number of experiments rendering a uniform method of procedure impossible. In the Tables which appear in this paper the latest time of testing each vaccine is noted. This does not by any means indicate the limit of potency except where such limit be expressly stated, but merely the latest date of testing.

Volatile Substances.

In the case of solutions of volatile substances, the only modifications of the above-mentioned procedure was:—

(*a.*) Instead of using weighed quantities of solutions required for admixture with vaccine, the equivalent volume of a certain known weight of the solution was determined; this volume or a multiple of it could at any time be easily and rapidly measured in a pipette.

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* *On the Influence of Anaerobic Conditions on the Extraneous Organisms of Glycerinated Calf Lymph.* By Mr. H. S. Fremlin, in the Report of the Medical Officer, Local Government Board, 1900-1901.

(*b.*) The weighed quantity of vaccine which had already been ground up in the machine was intimately mixed, by means of a sterilised pestle and mortar, with half the required amount of solution. This mixture was poured into a stock tube, after which the remaining half of the amount of solution was rapidly added, and the stock tube was immediately corked and sealed. The resulting mixture, therefore, contained the volatile substance in rather less quantity than did the original solution used, owing to the first portion of fluid having been exposed in the mortar.

(*c.*) Each tube was agitated for a few minutes until the contents appeared to be intimately mixed.

For convenience of reference and comparison, the various substances used in these experiments have been grouped as follows:—

Class A.—*Some Alcohols.*

Class B.—*Some Alcohol Derivatives and Allied Substances.*

Class C.—*Various Other Substances.*

Class D.—*Chloroform.*

Class A.—*Some Alcohols.*

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Accordingly selection was made of one or more alcohols, obtainable commercially, from each alcoholic group, and experiments were begun by mixing these substances either in their pure state, or in various strengths of solution in distilled water, with vesicular material. Altogether 80 experiments have been so made. Of the alcohols of the first group—the monatomic alcohols—four members have been used, namely, methyl alcohol, ethyl alcohol, isobutyl alcohol, and amyl alcohol. Of the alcohols of the second group—the diatomic alcohols—one was used, namely, glycol. Glycerine itself belongs to the triatomic group, and no other member of this group was obtainable. Of the tetratomic alcohols two have been used, erythrite and pentaerythrite. No pentatomic alcohol was obtainable, and but one hexatomic alcohol—mannite. Details of these experiments are noted in Table A.

Methyl Alcohol, CH_3OH.—Sixteen experiments have been made with aqueous solutions of this alcohol, varying in strength from 0·5 per cent. to 30 per cent. In each of the first nine experiments, in which solutions containing 0·5 per cent. to 10 per cent. of the alcohol were used, the extraneous micro-organisms either increased in number or there was a decrease so slight as to be practicably negligible. With the use of the 15 per cent. solution

Potency.			
At nd of	Experiment.	Control.	Number of Experiment.
month	+	+	1
month	+	+	2
month	+	+	3
month	+	+	4
month	+	+	5
month	+	+	6
month	+	+	7
month	+	+	8
month	+	+	9
month	+	+	10
week	?	+	11
week	-	+	12
week	?	+	13
week	-	+	14
week	-	+	15
week	-	+	16
weeks	+	+	17
weeks	+	+	18
weeks	-	+	19
onth	+	+	20
onth	+	+	21
onth	+	+	22
eek	+	+	23
eek	+	+	24
eek	+	+	25
eek	+	+	26
eek	+	+	27
eek	+	+	28
onth	+	+	29
onth	+	+	30
nth	+	+	31
nth	+	+	32
nth	+	+	33
nth	+	+	34
nth	+	+	35
nth	+	+	36
eek	+	+	37
eek	+	+	38

[*Continued.*

	Potency.		
of	Experiment.	Control.	Number of Experiment.
th	+	+	39
th	+	+	40
th	+	+	41
ks	-	+	42
k	-	+	43
k	?	+	44
k	-	+	45
k	?	+	46
hs	+	+	47
ks	+	+	48
ks	+	+	49
ks	+	+	50
ks	+	+	51
hs	+	+	52
hs	+	+	53
hs	+	+	54
hs	+	+	55
hs	+	+	56
hs	+	+	57
hs	-	+	58
ks	+	+	59
ks	+	+	60
ks	+	+	61
ks	+	+	62
ks	+	+	63
ks	+	+	64
ks	+	+	65
ks	+	+	66
hs	+	+	67
ks	+	+	68
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hs	+	+	70
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ks	+	+	72
hs	+	+	73
hs	+	+	74
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s	+	+	80

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a marked decrease however began to be apparent, and this was progressively more marked as solutions of higher strength were used.

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The first ten vaccines yielded vesicles at the end of one month, but the last five of these were of such poor quality as to suggest that contact with the respective solutions had impaired the potency of their specific organisms. The eleventh vaccine, mixed with a 20 per cent. solution of the alcohol, yielded a very poorly developed vesicle at the end of one week after mixture, while the twelfth vaccine, mixed with the same strength solution, failed to cause any vesiculation at all at the end of one week after mixture. Number 13 vaccine, mixed with a 25 per cent. solution of the alcohol, caused doubtful vesiculation, and number 14, of similar strength solution, caused no vesiculation one week after mixture; while in the case of the last two vaccines, of 30 per cent. solution strength, total loss of specific activity was also shown at one week after mixture. From the inoculation of all the control vaccines well-developed vesicles resulted.

It seems clear, therefore, that the activity of the specific germ of vaccine was affected in some degree before elimination of extraneous bacteria occurred, and that this activity was seriously impaired, if not altogether destroyed, as soon as marked reduction in the number of extraneous germs was effected.

Ethyl Alcohol, C_2H_5OH.—Twelve experiments were made with ethyl alcohol in solution in distilled water of strengths varying from 7 per cent. to 30 per cent. Up to a strength of 10 per cent. little or no elimination of extraneous organisms occurred. With a 15 per cent. solution some elimination was apparent at the end of the fourth week after mixture. With strengths of 20 per cent., 25 per cent., and 30 per cent. marked diminution in the number of extraneous germs occurred. All these twelve vaccines gave vesicles after inoculation, some at the end of eleven weeks, some at the end of a month, and others at the end of a week after mixture, with the exception of No. 3 experiment, where no vesiculation occurred. But though vesiculation was thus caused by all but one vaccine, in all cases when a 15 per cent. strength solution and upwards had been used the vesicles were so poorly developed as to suggest that the activity of the specific germ had been impaired.

Apparently, then, ethyl alcohol begins to cause diminution of extraneous bacteria when used in about the same strength solution in which methyl alcohol has this effect, namely, in a strength of 15 per cent. or 20 per cent.; while the specific germ of vaccine seems able to resist a solution of higher strength of ethyl than of methyl alcohol.

Isobutyl Alcohol, CH—CH_2 OH.—Ten experiments with this alcohol have given the following results: In strengths up to and including 2·5 per cent. little or no definite germicidal action on extraneous bacteria was shown. In one experiment with a 5 per cent. solution constant diminution in the number of these organisms was apparent however, but this diminution was not so advanced

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as in the case of the controls. In four experiments with a saturated watery solution of the alcohol—about 7 per cent.—early and marked reduction in the number of extraneous germs occurred, and the process was so marked that at the end of the first week but a small number of these bacteria showed growth on agar plates. This elimination was much more marked than in the case of the control vaccines, where some thousands of extraneous micro-organisms were alive at the end of the first and even at the end of the fourth week

This comparatively rapid germicidal action of isobutyl alcohol was confined to the extraneous germs; for in every case, inoculation of the vaccines on calves at the end of a week and in some cases of a month after mixture was followed by well-developed vesicles.

Amyl Alcohol, C_5H_{11} OH.—With this, the fourth and last of the monatomic alcohols used in these experiments, eight vaccines were mixed. Four of these were with half-saturated solutions. In each of these cases no germicidal action on extraneous micro-organisms was found. Four experiments made with a saturated watery solution—about 3 per cent.—however showed in two cases an entire absence of extraneous growth after the first 24 hours, and in the other two cases only six and two colonies respectively grew on surface agar at a similar interval after mixture of the vaccine. As regards the action of this substance on the specific germ of vaccine, three vaccines mixed with a half-saturated solution of the alcohol caused vesiculation at the end of one month after mixture, and the fourth mixed with the same strength solution failed to cause vesiculation at the end of eleven weeks, when the control vaccine was still potent. Two vaccines mixed with a saturated solution failed to cause any vesiculation one week after mixture, and two others mixed with the same strength solution were only followed by some slight reaction, doubtfully vesicular.

Propylene Glycol, CH_3—CH(OH)—CH_2OH.—A slightly viscid liquid with a pungent smell. This was the sole alcohol of the diatomic group which I was able to obtain. In one experiment, made with a solution of 0·5 per cent. strength, and two with a solution of 3·3 per cent. strength, a considerable decrease in the number of extraneous organisms was apparent at the end of the seventh week after mixture, but this decrease was not nearly so marked as in the case of the controls. Five experiments were made with a 5 per cent. solution, and of these the first two gave similar results to those just mentioned, but the last three showed a much greater and more rapid elimination of extraneous germs, so that at the end of the first week the greatest number of these germs in any of the three vaccines was 267 per loopful, where originally 18,200 per loopful had been present. This was a more rapid elimination than occurred in the controls. At the end of the fourth and seventh weeks after mixture elimination was also more marked in the experimental vaccines than in the controls. Three experiments were made with a 10 per cent. solution, in which a great reduction in the number of extraneous organisms occurred at the end of 24 hours after mixture; at the end of the first week two of these vaccines showed no extraneous growth, while the third showed but twenty-one colonies; at the end of the

seventh week also no extraneous bacteria appeared. In one vaccine, mixed with a 20 per cent. solution, the elimination of extraneous organisms was even more rapid.

Thus these last seven vaccines mixed with propylene glycol were free from extraneous growth considerably sooner than were their controls. All the glycol vaccines, with the exception of that mixed with the strongest solution, gave rise to well-developed vesicles six, seven, and eight weeks after mixture. Thus propylene glycol apparently has the power in aqueous solution of suitable strength to kill the extraneous bacteria of vaccine, while the activity of the specific germ is at the same time left in such condition as to enable it to cause typical vesiculation on calves.

Glycerine, Propenyl Alcohol, $C_3 H_5 (OH)_3$.—This was the only available alcohol of the triatomic series, and was used in the control vaccines throughout these series of experiments.

Erythrite $C_4 H_6 (OH)_4$, and *Pentaerythrite* $C (CH_2 OH)_4$, are the two tetratomic alcohols which I have been able to obtain, and for the latter of these I am indebted to Dr. Harden of the Jenner Institute of Preventive Medicine. *Mannite* $C_6 H_8(OH)_6$ was the only obtainable hexatomic alcohol. No alcohol of any higher series could be procured.

Eight experiments on vaccine material were made with erythrite, eight with pentaerythrite, and six with mannite. Their action was so similar that it will be convenient to describe the experiments together.

All three alcohols were solid bodies, soluble in water, and were used in strengths of half saturation and saturation. While in one or more experiments a rather smaller number of extraneous bacteria appeared at the end of 24 hours, one, four, or seven weeks after mixture than were originally present, the majority of these vaccines showed a great increase of extraneous organisms at the above-mentioned intervals, indicating that these alcohols, so far from having germicidal values, appeared to act as media favourable to bacterial growth.

These vaccines without exception gave rise to vesicles on calves at the end of seven, eight, nine, and eleven weeks after mixture, showing apparently unimpaired activity of the specific germ of vaccine.

This concludes the present series of experiments with alcohols.

Thus it appears that—

1. Some of the lower monatomic alcohols in weak aqueous solution are harmless to the life of both the specific and the extraneous micro-organisms of vaccine, while in solutions of higher strength they are capable of more or less rapidly destroying the vitality of the extraneous bacteria and the potency of the specific germ of vaccine.

Ethyl alcohol seemed to have a less injurious effect on the specific germ of vaccine than did methyl alcohol in equal strength solutions, while isobutyl alcohol proved an exception altogether to the rule that the specific germ suffered injury. This alcohol,

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indeed, seemed to have powers analogous to glycerine in that, while it killed out the extraneous organisms, the specific germs were capable of causing vesiculation some time after the date of mixture.

2. Glycol, the representative of the diatomic group of alcohols, in aqueous solution of 10 per cent. strength, killed extraneous micro-organisms in from twenty-four hours to one week after mixture and allowed the specific germs to survive; but in strengths above 10 per cent. the specific germs underwent entire loss of potency in addition to the extraneous germs being killed.

3. An alcohol of the next group—the triatomic—namely, glycerine, in 50 per cent. solution in water, killed the extraneous organisms of vaccine in from 4–8 weeks and allowed the specific germ to survive, as is shown by the control vaccines of these experiments. Pure glycerine possesses a similar action.

4. Alcohols of groups higher than the triatomic, namely, some tetratomic and hexatomic alcohols, while they allow the specific germ to survive for considerable periods of time, as in the case of glycerine, have no germicidal value as regards the extraneous organisms; indeed, they seem to provide media favourable for their growth.

The results of these experiments with alcohols may be thus tabulated:—

Group of Alcohol.	Action on Extraneous Micro-Organisms.	Approximate Time of Action.	Action on Specific Micro-Organisms.	Approximate Time of Action.
Monatomic ..	Germicidal	24 hours to 1 week	Germicidal	1 week.
Diatomic	Germicidal	24 hours to 1 week	Non-Germicidal	2 months.
Triatomic	Germicidal	4 to 8 weeks	Non-Germicidal	2 months.
Tetratomic ..	Non-Germicidal	7 weeks	Non-Germicidal	7 weeks.
Pentatomic* ..	—	—	—	—
Hexatomic ..	Non-Germicidal	7 weeks	Non-Germicidal	7 weeks.

Thus, in the lowest group of alcohols, germicidal action on the extraneous micro-organisms and loss of potency of the specific germ is shown, while as higher alcohols are used—diatomic and triatomic—harmful action on the extraneous bacteria only is shown, potency of the specific germ being retained, and as still higher alcohols are used—tetratomic or hexatomic—germicidal action even on the extraneous micro-organisms is lost, extraneous and specific germs alike remaining alive for many weeks.

In the experiments with the four monatomic alcohols it is not easy to explain why isobutyl alcohol should have a "selective" germicidal influence. It may be that the monatomic alcohols have progressively less injurious effect on the specific organisms while they retain their germicidal influence on the extraneous bacteria, and that, as higher monatomic alcohols still are used—the "oily"

* None obtainable.

and solid paraffin-like bodies in appearance—germicidal power is altogether lost similarly as in the cases of tetra or hexatomic alcohols. Of this it is impossible to speak definitely at present. Certainly ethyl alcohol, while it possesses the germicidal action of methyl alcohol on extraneous bacteria, is less injurious to the potency of the specific germ of vaccine, and this difference is still more marked in isobutyl alcohol. But amyl alcohol, a still higher member of the series, appears to have no such "selective" germicidal value, for the extraneous bacteria were killed by a saturated solution of it in 24 hours or a week, while the specific germ of vaccine was rendered practically inactive in the same space of time.

It will be seen that, generally speaking, in these experiments the specific germ of vaccine has a higher resistance to germicidal influences than have the extraneous micro-organisms.

CLASS B.—*Some Alcoholic Derivatives and Allied Substances.*

Of these substances eight only were obtainable. Six of these are related to the triatomic alcohol glycerine, one to the diatomic alcohol glycol, and one is a member of the amido acid group.

Acrolein.—Acrylic aldehyde, allyl aldehyde, CH_2 CH—CH O, is produced by heating glycerine with bisulphate of potash. It is a volatile liquid, resembling lemon juice in colour. It has an acrid and very pungent smell, while the vapour very quickly irritates the eyes and mucous membrane of the nose in a similar way to the vapour of formalin.

Seven experiments were made with watery solutions of this substance (experiments 1–7, Table B) in strengths varying from 1–1,000 to 1–50. Generally the effect was strongly germicidal on the extraneous organisms, while the specific organisms also quickly lost their potency. In the case of the 1–1,000 solution, which was mixed with a vaccine originally containing 16,500 extraneous organisms per loopful, the number was reduced to 206 at the end of 24 hours, to 73 at the end of the first week, and to nil at the end of the fourth week.

In the next experiment, where the strength of the solution used was 1–500, a still stronger germicidal action was manifested. In one experiment, where a solution of strength 1–100 was used, and in two experiments where solutions of strength 1–50 were used, no extraneous growth occurred at either the end of 24 hours after mixture of the vaccine, or at the end of the 1st, 4th, or 7th weeks.

The action of acrolein on the specific germ of vaccine quickly caused loss of potency, for each of these eight vaccines failed to produce vesiculation at the end of the 6th, 7th, or 8th weeks after mixture. Two experiments, indeed, with a 1–500 solution, not only failed to show any decrease in the numbers of extraneous

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organisms at the end of the 4th or 7th weeks, but on the contrary an increase. It may be that the method of storage proved defective in these two cases, but in opposition to such surmise is the fact that both vaccines failed to show potency at six or seven weeks. The germicidal action of acrolein appears to be similar to that of formalin, as shown in the small number of experiments I made with that substance last year.

Glyceric Acid.—Propane diolic acid, $C_2H_3(OH)_2(CO_2H)$, is a triatomic monobasic acid obtained by means of the slow oxidation of the triatomic alcohol glycerine. It is a heavy syrupy liquid, soluble in water.

In one of the four experiments made with this substance with a solution of 1–65, strong germicidal action on the extraneous organisms was shown; in the three other experiments, which included a 5 per cent. solution, this action was much weaker. In these last three experiments, however, organisms were present not usually occurring in freshly collected vaccine.

The specific germ of vaccine failed to cause vesiculation in the case of each of these vaccines when the controls were still active.

Glyceryl Phosphoric Acid, $C_3H_5(OH)_2$ $(O.\ PO_3H_2)$, is an ether of glycerine which that substance forms with phosphoric acid.

Two experiments only were made with this substance. In one of these little or no germicidal action on extraneous organisms was evinced, and in the other organisms increased in number. In both cases the specific germ of vaccine failed to show any sign of activity at the end of three or four weeks.

Mono-Acetin, $C_3H_5\left\{\begin{matrix}(OH)_2\\ O.\ C_2H_3O\end{matrix}\right.$;

Di-Acetin, $C_3H_5\left\{\begin{matrix}(OH)\\ O.\ C_2H_3O_2\end{matrix}\right.$; and

Tri-Acetin, $C_3H_5\ (O.\ C_2H_3O)_3$,

are colourless thick liquids, soluble in water. They are all glycerine ethers of acetic acid.

From their similarity of action on the germs of vaccine, the three sets of experiments may be described together.

Four experiments were made with each substance. In the solutions of weaker strength extraneous organisms appeared either in greater numbers, at the end of the 4th and 7th weeks, than were present originally in the vaccine, or there was a decrease so slight that one could hardly say it was due to any germicidal action. As the stronger solutions were used, however, marked germicidal action became apparent, and extraneous organisms were more or less quickly eliminated, while in three experiments (numbers 17, 21, and 25) great reduction in numbers occurred at the end of the first 24 hours. In comparing the effects of solutions of equal strength of these three ethers, tri-acetin seemed to exert

Potency.			Number of Experiment.
end of	Experiment.	Control.	
onths	—	+	1
onths	—	+	2
weeks	—	+	3
weeks	—	+	4
onths	—	+	5
weeks	—	+	6
weeks	—	+	7
weeks	—	+	8
weeks	—	+	9
weeks	—	+	10
weeks	—	+	11
weeks	—	+	12
weeks	—	+	13
onths	+	+	14
onths	—	+	15
weeks	—	+	16
weeks	—	+	17
onths	—	+	18
onths	—	+	19
weeks	—	+	20
weeks	-	+	21
weeks	—	+	22
weeks	—	+	23
weeks	—	+	24
weeks	-	+	25
onths	—	+	26
onths	—	+	27
onths	—	+	28
weeks	—	+	29
weeks	—	+	30
weeks	+	+	31
weeks	+	+	32
onths	+	+	33
weeks	+	+	34
weeks	+	+	35

a stronger germicidal action than either di-acetin or mono-acetin. Only that vaccine which had been mixed with the weakest solution of mono-acetin, of all these experimental vaccine, caused vesiculation two months after mixture.

Glycollic Acid, $CH_2(OH)-CO.OH$, a polyatomic monobasic acid, occurs, as colourless crystals, from the oxidation of the diatomic alcohol glycol with dilute nitric acid. It is easily soluble in water.

In the first experiment made with this substance, the behaviour of the extraneous organisms appeared to be erratic; a great decrease in their numbers was noticeable at the end of the first 24 hours, while at the end of the first week the number of colonies on the agar-agar plates was more than double the number originally observed. This number again decreased at the end of the 4th week, and still further at the end of the 7th week.

The vaccines mixed with stronger solutions showed marked and constant germicidal action.

When these five vaccines were inoculated on calves no vesiculation resulted from any of them. Thus potency was affected as much, or more, than the life of the extraneous germs.

Glycocoll, $CH_2(NH_2)-CO.OH$, amido-acetic acid, is a derivative of glycollic acid, and is the simplest representative of the group of amido-acids. It occurs in crystals and is freely soluble in water. In each of the five experiments a saturated watery solution was used; this solution formed an odourless, heavy, syrupy liquid with a sweet taste.

In all cases elimination of extraneous organisms from the vaccine occurred, and the rate of elimination corresponded closely with that obtaining in the glycerine controls, save that at the end of the first 24 hours and of the first and fourth weeks the elimination was more marked in the experimental vaccines, while at the end of the seventh week the experimental vaccines and their controls were practically on equal terms. The specific germs were apparently unaffected by these glycocol solutions at the end of six, seven, and eight weeks, for vesicles of as good quality as those resulting from their controls followed inoculation in every case.

Thus the action of glycocoll on vaccine resembled that of glycerine, and seems in these experiments to have been very similar also to the action of some of the carbohydrates used in last year's experiments.

Considering this group as a whole, the first seven substances exhibited germicidal action, in a greater or less degree, on the extraneous bacteria, and affected specific germs also in so far as they lost their potency. Only one substance of the group, namely, glycocol, was shown to have a "selective" germicidal action in that it killed out extraneous organisms and apparently did not injure the activity of the specific germ.

APP. C, No. 2.

The action of Chloroform and other substances on Micro-Organisms of Vaccine; by Dr. Green.

CLASS C.—*Various other Substances.*

This class of experiments, the details of which are given in Table C, comprises fifteen substances. The first ten are new to these experiments, while the other five were used in similar experiments and commented upon last year.

The first four members of this groups are tannic acid, oxalic acid, formic acid, and lactic acid.

Tannic Acid has been used in four experiments. In strengths 1–400, 1–200, and 1–100, little or no germicidal action was evidenced; in all three cases, while a smaller number of colonies appeared at the seventh week than were originally noted in the vaccines, the original number of micro-organisms had increased in number at the first and fourth weeks, but, as in some other acid vaccines, this was probably due to increase of a species of bacteria not strictly associated with crude calf vaccine. These vaccines gave very poor vesicles on calves at the end of seven weeks after mixture. In the 1–50 vaccine, though considerable numbers of extraneous organisms were present, no vesiculation occurred subsequent to inoculation of the vaccine on a calf eight weeks after mixture.

Oxalic Acid.—This substance showed considerable germicidal action, which appeared to be as marked in some cases at the end of the first 24 hours as at the end of first or fourth weeks. This germicidal action was intensified in the stronger solutions, but apparently the activity of the specific germ was also considerably affected, for none of the vaccines caused vesiculation at the end of six, seven, or eight weeks after mixture.

Formic Acid.—Marked germicidal action on the extraneous bacteria was noticed 24 hours after mixture, especially in the vaccine mixed with the stronger solutions. Only in the three weakest solution vaccines did the specific organisms survive for eight weeks, and in every case the vesicles were very poorly developed compared with the vesicles resulting from the controls.

Lactic Acid.—This substance might have been included in Class B, for it can be produced by the oxidation of glycol; as it can, however, be obtained in several other ways, it has been included here.

In six instances in which lactic acid was used, reduction in numbers of extraneous micro-organisms occured at the end of 24 hours. A great reduction was noticeable in the vaccines mixed with the solutions of higher strengths. In the vaccines mixed with the three weaker solutions, after the first 24 hours extraneous organisms increased in numbers again to a considerable extent; and here again the increase was due to a variety of micro-organisms not usually found in freshly-collected vaccine.

In only the first three vaccines was potency retained at the end of six and seven weeks after mixture.

t end of	Potency. Experiment.	Control.	Number of Experiment.
weeks	+	+	1
weeks	+	+	2
weeks	+	+	3
weeks	-	+	4
weeks	-	+	5
weeks	-	+	6
weeks	-	+	7
weeks	-	+	8
weeks	-	+	9
weeks	-	+	10
weeks	+	+	11
weeks	+	+	12
weeks	+	+	13
weeks	-	+	14
weeks	-	+	15
weeks	-	+	16
weeks	+	+	17
weeks	+	+	18
weeks	+	+	19
weeks	-	+	20
weeks	-	+	21
weeks	-	+	22
weeks	+	+	23
weeks	-	+	24
weeks	-	+	25
weeks	-	+	26
weeks	-	+	27
weeks	-	+	28
weeks	+	+	29
weeks	+	+	30
weeks	+	+	31
weeks	-	+	32
weeks	-	+	33

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Potency.			
end of	Experiment.	Control.	Number of Experiment.
weeks	+	+	34
weeks	+	+	35
weeks	-	+	36
weeks	-	+	37
weeks	+	+	38
weeks	+	+	39
weeks	+	+	40
weeks	+	+	41
weeks	+	+	42
weeks	+	+	43
weeks	+	+	44
weeks	+	+	45
months	+	+	46
months	+	+	47
months	+	+	48
months	+	+	49
months	+	+	50

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Ammonia.—Six experiments were made with ammonia in various strengths. Some germicidal action was manifested, especially in the stronger solution vaccines, by the lessening in numbers of extraneous micro-organisms. But potency of the specific germ was also lost; in only one case—that of the weakest solution vaccine—did vesiculation result after inoculation.

Hydrogen Peroxide.—In five vaccines mixed with solutions of hydrogen peroxide of various strengths, only feeble germicidal action was exhibited towards the extraneous micro-organisms. In the case of the 50 per cent. solution only did this action approximate to the germicidal action of glycerine on extraneous bacteria of the controls. Potency was lost at the end of seven weeks after mixture in two out of the five vaccines.

Turpentine, Creosote, Peppermint, and Eucalyptol were mixed with vaccine in the following way:—0·5 cc. of experimental substance were shaken up with 100 cubic centimetres of distilled water, and four cubic centimetres of the mixture were immediately mixed with one gramme of vaccine.

Turpentine.—This showed no germicidal action in the first of the two experiments made with it; and but little in the second, for many extraneous organisms were alive at the end of the seventh week after mixture. In both cases the specific germ retained some potency.

Creosote.—This was used for two experiments, and in both the extraneous germs were killed at the end of the first 24 hours; the specific germ had lost all potency by the end of the sixth week in both vaccines.

Peppermint.—Feeble germicidal action towards the extraneous bacteria was shown in the two experiments made, and the potency of the specific germ was in each instance apparently unaffected, for excellent vesicles resulted from inoculation on calves eight weeks after mixture.

Eucalyptol.—While less germicidal action towards extraneous germs was apparent in the two experiments made with this substance than was noticed in their two controls, yet material reduction in the number of these microbes occurred at the end of the fourth week in each case. Eight weeks after the mixture of these vaccines very well-developed vesicles followed their inoculation on calves, showing that no harm had been done to the activity of the specific germ of vaccine.

Generally, in vaccines mixed with any of the foregoing ten substances, where any marked germicidal action on extraneous bacteria was shown, the potency of the specific germ of vaccine also suffered to a greater or less extent. This was evidenced in some cases by poorly developed vesicles compared with the vesicles resulting from the control vaccine, and in others by total failure of vesiculation. In many cases where extraneous organisms were but slightly lessened in numbers, the potency of the specific germ of vaccine was only partially affected.

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The most noticeable exception to this occurred in the case of the two vaccines mixed with eucalyptol, which approximated somewhat to the type of their glycerine controls.

The remaining five substances—biborate of soda, boracic acid, saccharine, carbolic acid and water, and carbolic acid and glycerine—are those which, with the exception of chloroform, gave the best results in my last year's experiments. As these former experiments were few in number, one or two experiments with each substance—in the case of saccharine three—have been repeated this year as a further test.

This additional series of experiments has shown practically identical results with those obtained last year. In every case, except in two experiments with saccharine, the germicidal action on extraneous micro-organisms was more marked than that of the glycerine of the controls, while at six weeks and two months after mixture well-developed vesicles resulted on calves five days after inoculation, comparing in each instance favourably with those following inoculation of the controls.

CLASS D.—*Chloroform.*

Owing to the rapid manner in which, in the first experiments in 1900 and 1901, chloroform in saturated watery solution was found to kill the extraneous organisms of vaccine, while the specific germ of vaccine retained its potency apparently unimpaired, further experiments have been made during the past year of mixing vaccines with this substance. They consist of four series of experiments.

The experiments of the first series were carried out by the methods described by me last year, and under similar conditions.

SERIES 1.

It will be seen from Table D that these experiments were five in number, and that two of these were subdivided, making seven experiments in all.

The original vaccine, after being passed through the triturating machine, was divided into either two or three portions.

The portions marked (*a*) in Table D were mixed with four times their own weight of chloroform water.

The portions marked (*b*) in Table D were mixed with four times their own weight of a 50 per cent. solution of glycerine and chloroform water.

One portion in each experiment was mixed with a 50 per cent. solution of glycerine and water to serve as a control.

These seven experiments corroborate those reported last year. In every case there was a large initial number of extraneous micro-organisms present in the vaccines. These, in the case of the

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TABLE D.

Chloroform, Series 1.

+ = Potent. — = Non-potent.

Number of Experiment.	Number of Colonies of Extraneous Micro-organisms.					Free from Extraneous Micro-organisms.		Potency.		
	At mixing.	Experiment.		Control.		Experiment.	Control.	At end of	Experiment.	Control.
		At end of	No.	At end of	No.	At end of	At end of			
1. (*b*)	41,000	1 week	0	1 week	5,900	1 week	7 weeks	4 months	+	+
2. (*a*)	22,000	24 hours	39	1 week	3,600	1 week	7 weeks	4 months	+	+
(*b*)			148			1 week			+	
3. (*a*)	102,000	1 week	0 (capillary tube)	1 week	19,000 (loop)	1 week	2 months	4 months	+	+
(*b*)			0 (capillary tube)			1 week			+	
4. (*b*)	19,000	1 week	0	1 week	4,600	1 week	2 months	3 months	+	+
5. (*b*)	17,100	1 week	0	1 week	4,700	1 week	7 weeks	2 months	+	+

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experimental mixtures, were eliminated at the end of the first week. In two cases (experiments Nos. 3*a* and 3*b*) a capillary tubeful of vaccine showed no extraneous growth at the end of the first week after mixture, while one loopful of the control at the same time yielded 19,000 extraneous organisms. Originally there had been 102,000 extraneous organisms per loopful present in the vaccine. In two cases (experiments 2*a* and 2*b*) elimination was almost complete at the end of the first 24 hours. Had the other vaccines been tested as early as 24 hours, it seems probable that equally rapid elimination would have been shown in them also. The controls, on the other hand, were in no case free from extraneous micro-organisms in less than seven weeks, and in two cases two months had elapsed before this result was obtained.

All experimental and control vaccines were potent two, three, and four months after preparation; while the former in all cases gave rise to as satisfactory vesicles as the latter.

Series 2.

This series of experiments was also carried out by the same methods and under similar conditions as last year's experiments, with the exceptions (*a*) that the chloroform was not evaporated from the vaccines at any time; (*b*) that the times for pouring plates were at regular intervals, namely, at 24 hours after mixture, and at the ends of the 1st, 4th, and 7th weeks after mixture.

This series was instituted because it was thought desirable to ascertain the action on the micro-organisms of vaccine of (*a*) chloroform water, (*b*) of chloroform water and glycerine, (*c*) of these two solutions with excess of chloroform, and of (*d*) pure chloroform. Accordingly, as Table E shows, ten experiments were made, each subdivided into five, making a total of 50 experiments.

The vaccine used for the primary ten experiments was in each case of more than six grammes weight, and was removed from one calf. After being ground up in the triturating machine it was subdivided into six parts of one gramme each in weight; and was dealt with as follows:—

One gramme was mixed with four times its own weight of chloroform water. These vaccines are marked (*a*) in Table E.

A second gramme was mixed with four times its own weight of a 50 per cent. solution of glycerine and chloroform water. These vaccines are marked (*b*) in Table E.

A third gramme was mixed in the same manner as (*a*), but excess of pure chloroform was afterwards added to the depth of half an inch at the bottom of the stock tube. These vaccines are marked (*c*) in Table E.

A fourth gramme was mixed in the same manner as (*b*), but excess of pure chloroform was afterwards added to the depth of half an inch at the bottom of the stock tube. These vaccines are marked (*d*) in Table E.

	Potency.	
end of	Experiment.	Control.
nonths	+ + - - -	+
nonths	+ + + + -	+
nonths	+ + - - -	+
nonths	+ + - - -	+
nonths	+ + + + -	+

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Potency.		
nd of	Experiment.	Control.
nths	+ + - - -	+
nths	+ + - - -	+
nths	+ + + - -	+
nths	+ + - + -	+
nths	+ + - + -	+

A fifth gramme was placed in the stock tube in its freshly ground up condition, and pure chloroform was added so as to fill the tube. These vaccines are marked (*e*) in Table E.

A sixth gramme was mixed with four times its own weight of a 50 per cent. solution of glycerine and distilled water, as a control.

The number of extraneous micro-organisms at the time of mixture were in these, as in all the other experiments, considered to be equivalent to the number present in a loopful of the control vaccine at the time of mixing.

An inspection of Table E will show that while at the time of mixture there were present in all vaccines a large number of extraneous organisms, at the end of the first 24 hours these were almost eliminated in the (*a*) and (*b*) vaccines, while in the (*c*) and (*d*) vaccines, where pure chloroform was present in excess, no growth of extraneous organisms was present save in two cases, where one colony only was noticed. In the vaccines prepared with pure chloroform alone—the (*e*) vaccines—no extraneous growth was observed in any case. In the (*a*) and (*b*) vaccines, where elimination was not complete at the end of the first 24 hours, it was complete at the end of the first week except in a few cases. In the case of experiments 2 (*a*) and 2 (*b*), where 120,000 extraneous micro-organisms were originally present per loopful, a capillary tubeful of vaccine showed no extraneous growth at the end of the first week.

No extraneous growth was noticed in any vaccine at examinations made later than the end of the first week.

As one would expect to be the case, the germicidal action of chloroform is stronger where it is in excess than where only a saturated solution is employed, for germicidal action was practically complete in every case at the end of the first 24 hours where pure chloroform in excess was used, and practically complete in every case at the same period of time in the vaccines where pure chloroform was used.

As regards the action of chloroform on the specific germ of vaccine, it will be seen that where chloroform was present in saturated solution only, namely, in the (*a*) and (*b*) experiments, potency was shown many months after mixture—in four cases for 7 months and in four cases for 8 months. The resulting vesicles on the calf were in each case as well developed and as typical as those of the corresponding controls; and this occurred in spite of the fact that from none of these vaccines was the chloroform evaporated as a routine measure, though some accidental evaporation probably took place.

Of the vaccines mixed with excess of chloroform, however, very different results as to their potency were obtained. Only seven out of twenty vaccines gave vesicles at the same time as their controls, the remainder causing no vesiculation. Thus in these thirteen cases the specific properties of the vaccine had been entirely destroyed.

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Of the vaccines mixed with pure chloroform, not one caused vesiculation at any time of testing.

From these experiments it seems clear that while chloroform in saturated solution in distilled water quickly kills the extraneous germ, it causes apparently no damage to the specific germ of vaccine. Pure chloroform, on the other hand, is strongly inimical to the potency of the specific germ and quickly germicidal to the extraneous germs of vaccinia. Where in the (*c*) and (*d*) experiments the specific or extraneous germs survived they probably did not come into contact with the excess of chloroform.

In these chloroform experiments there have been six instances of incomplete elimination of extraneous micro-organisms. These exceptions to the general rule have not been included in the series here described, as it has been found that the defective elimination was due, not to any want of germicidal power on the part of chloroform water, but to the fact that sufficient precaution had not been taken to prevent evaporation of the chloroform. This is an important point and emphasises what has gone before, namely, that the chloroform must not be in excess of saturated strength or the potency of the vaccine will be impaired, nor must it be too weak, or elimination of the extraneous will not be complete, but that the requisite strength of solution must be used—that is, saturation—when marked germicidal action on the extraneous bacteria is shown, while the specific properties of vaccine are left unimpaired, at any rate for a considerable period of time.

In these six cases of defective elimination of extraneous micro-organisms it was easy, after centrifugalisation, to pipette off the liquid from the vesicular material. This was done, and fresh chloroform solution was substituted in equal volume to the fluid removed; the stock tubes were recorked and sealed. In every case elimination of extraneous micro-organisms was found to be complete 24 hours later, while potency of the specific virus was retained for some months.

To prevent entirely any undesired evaporation of chloroform from a vaccine, and to ensure accuracy and uniformity in the mixing, a further series of experiments was instituted, and the following method adopted:—

SERIES 3.

First, suitable glass-stoppered vessels were selected for use as stock tubes. These were ordinary glass weighing tubes of equal cubic capacity, having well fitting glass stoppers.

Secondly, the exact quantity of vesicular material, glycerine, and water present in one of these stock tubes full of control vaccine was estimated. This was done as follows:—

1. The cubic capacity of a weighing tube was ascertained; this for any vessel may be called X,

Number of Experiment.	Potency.			Number of Experiment.
	[illegible]d mi[illegible]	Experiment.	Control.	
1	44,[illegible]ths	+	+	1
2	3,[illegible]ths	+	+	2
3	31,[illegible]ths	+	+	3
4	39,[illegible]ths	+	+	4
5	58,[illegible]ths	+	+	5
6	88,[illegible]ths	+	+	6
7	[illegible]ths	+	+	7
8	87,[illegible]ths	+	+	8
9	63,[illegible]ths	+	+	9
10	51,[illegible]ths	+	+	10

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2. The actual weight of contents of X, when filled with the control vaccine, made up of one part by weight of vesicular material, two parts glycerine, and two parts distilled water, was ascertained; this weight may be called W.

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Then W when split up into its component parts may be represented thus:—

$$W = \begin{cases} \frac{1}{5} \text{ (vesicular material).} \\ \frac{2}{5} \text{ (pure glycerine).} \\ \frac{2}{5} \text{ (distilled water).} \end{cases}$$

Accordingly for each experiment these quantities of materials were taken. The weighed vesicular material and weighed glycerine, making together $\frac{3}{5}$ W were intimately mixed by means of a sterilised pestle and mortar and poured into stock tubes. The remaining capacity of each stock tube was filled with chloroform water directly from the bottle, and the quantity of chloroform water, added to each tube completed the remaining $\frac{2}{5}$ W. The tubes were then tightly stoppered and sealed with melted paraffin. They were next agitated for a few minutes to thoroughly mix the contents, and finally placed in a dark cupboard.

It may be remarked that the proportions of the vaccine calculated in the above way corresponded very closely to those mixed by the former method.

In previous chloroform vaccines I had poured no agar agar-plates earlier than 24 hours after mixture, but in this series it seemed desirable to make an earlier examination. Accordingly, from these vaccines, plates were poured at frequent intervals after mixture, as reference to Table F will show, and at the end of the first 24 hours and the first, fourth, and seventh weeks. From the control vaccines plates were poured at the time of mixture and at the end of 24 hours, and the first, fourth, and seventh week afterwards.

The chloroform was not evaporated from any vaccine, so that it might be ascertained whether its presence had any deleterious effect on the specific germ.

As noted in Table F, the elimination of extraneous bacteria from the vaccines was striking. There was a very marked reduction in the numbers of these bacteria as early as half an hour after the mixture of each vaccine. This reduction was progressive, so that in only one case was any extraneous growth seen six hours after mixture, and then but one colony appeared, although at this time the control vaccine showed a large number of extraneous organisms, and continued to show some such growth as late as the seventh week after mixture.

The results obtained by the use of this method certainly suggest that the prevention of evaporation of chloroform from the vaccines has a marked influence on the rapidity of elimination of their extraneous micro-organisms.

The potency of these vaccines was very satisfactory; vesicles resulted in every case from their inoculation on calves as long as

two months after mixture, giving rise to as good vesicles as did their controls, although, as has been already stated, the chloroform was not evaporated, as would usually be the case after elimination of extraneous bacteria.

With the view of partially controlling this series, and at the same time ascertaining the action on vaccine of larger proportional quantities of glycerine and chloroform water solution than had been used in the foregoing series, a fresh series was begun.

Series 4.

In this series the same method of mixture and storage in glass-stoppered vessels was used. Each vaccine was mixed, however, so that one part of vesicular material was added to *six* times its own weight of a 50 per cent. glycerine and chloroform water solution. The proportions in this case were—

$$W = \begin{cases} \frac{1}{7} \text{ (vesicular material).} \\ \frac{3}{7} \text{ (pure glycerine).} \\ \frac{3}{7} \text{ (chloroform water).} \end{cases}$$

Table G shows the results of these experiments.

The numbers of extraneous bacteria originally present in some of these vaccines were very high. At the end of half an hour after mixture slightly greater reductions in those numbers occurred than was noticeable in the extraneous bacteria of the preceding series at the corresponding time.

Examined two hours after mixture, three of these vaccines showed no growth of extraneous organisms, while the remainder at the corresponding time showed from one to eleven extraneous organisms per loopful.

Five hours after mixture only two vaccines showed any extraneous growth, and these but one organism per loopful.

All the control vaccines, with the exception of No. 1 control, showed extraneous growth at the end of the seventh week after mixture.

All experimental vaccines gave rise to typical vesicles on calves at intervals of one month, six weeks, and two months after mixture, the vesicles being as well developed as those of the controls.

As in the preceding series, chloroform was not evaporated from any of these vaccines.

It would appear from these results that the greater proportion of chloroform water to vesicular material—namely, six parts of the former to one of the latter—in this series, exercised a slightly more rapid germicidal action than did the smaller proportion—four to one—in the preceding series, while apparently the potency of the specific germ was not more impaired; but on this last point it is impossible to speak definitely, as the vaccines of this series were not tested for potency at quite so late a date as those of Series 3.

	Potency.		
t end of	Experiment.	Control.	Number of Experiment.
months	+	+	1
months	+	+	2
months	+	+	3
months	+	+	4
months	+	+	5
months	+	+	6
weeks	+	+	7
weeks	+	+	8
month	+	+	9
month	+	+	10

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So far the following points have been demonstrated :—

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1. Pure chloroform, whether used alone, in excess in chloroform water, or in excess in a 50 per cent. solution of chloroform water and glycerine, is rapidly destructive to the extraneous bacteria of vaccine, with the exception of the spore-bearing organism *bacillus mesentericus*, and rapidly causes the potency of the specific germ to be destroyed.
2. Chloroform water, or a solution of 50 per cent. glycerine and chloroform water, is destructive to the extraneous bacteria of vaccine, with the exception of *bacillus mesentericus*, in about six hours, while it has left the vaccine specific germ potent for as long as eight months. In the control vaccine, prepared with a 50 per cent. solution of glycerine and water, elimination of extraneous bacteria rarely took less than, and was not often not complete in, seven weeks. Here also *bacillus mesentericus* proved resistant to the germicidal influence. In no case did a control vaccine give rise to better vesicles than the vesicles originating from an experimental vaccine.

Other points have been touched on in these experiments, but further work is needed in order to draw definite conclusions with regard to them. One of these points is the desirability of using or omitting glycerine in the preparation of chloroform vaccine. So far, although several such vaccines have been mixed, with and without the presence of glycerine, it has not been practicable to do more than draw conclusions as to the relative germicidal values of the two methods, and these values are apparently equal. Where glycerine has been used in addition to chloroform water the advantages have been solely due to the increased viscidity and specific gravity of the mixed vaccines, which have thus been easier of manipulation; that is to say, the uses of glycerine so far in this connection have been strictly those of an "emulsifying" medium, and the uses of chloroform have been strictly those of a very rapidly acting "selective" germicide. Further experiments are needed to determine the relative keeping properties of chloroform vaccine, with or without the presence of glycerine. So far, all that is definitely known is that both these kinds of vaccine will retain their potency for several months. It would seem probable from analogy that vaccine mixed with any germicidal substance must suffer in some degree loss of potency; and possibly it will be found that combination of chloroform water and glycerine may prove more detrimental to prolonged activity than the action of chloroform water alone continued for only such time as is necessary for the elimination of the extraneous micro-organisms.

Conclusions.

In the foregoing experiments it has not been possible to completely investigate the action of every substance used, but the endeavour has been made to perform a number of experiments

sufficient to give a definite indication of the action of the various substances on the micro-organisms of vaccine. Where any especially interesting results have been obtained, it is hoped, later on, to make investigations of such substance more in detail. So far, chloroform is the only substance with which any great number of experiments has been made.

In determining the presence or absence of life of micro-organisms in these experiments I have, in the case of extraneous micro-organisms, been guided principally by the presence or absence of growth on nutrient media.

As to the condition of the specific germ of vaccine, I have been guided entirely by its capability, or incapability of causing vesiculation, after inoculation on calves; that is, by its potency or non-potency. In the former case the virus must have been alive, and in the latter case this may or may not have been so, but in any case it had suffered to the extent of losing its specific properties.

Thus the foregoing comparisons between extraneous and specific germs are not strictly equal, but the inequality has favoured investigation of the essential points which determine the merits or demerits of vaccine. These are :—

(*a.*) The presence or absence of living extraneous micro-organisms capable of growth on surface agar.

(*b.*) The pathogenic activity of the specific germ.

The present experiments confirm those of last year in that—

1. Some substances experimented with have shown either an entire absence of germicidal action towards the extraneous germs of vaccine, or even in some cases a beneficent action towards them, so that they have progressively increased in numbers, together with an absence of any apparent injurious effects on the specific germ. These substances include erythrite, penta-erythrite, and mannite.

2. While in many experiments germicidal action has been shown towards the extraneous micro-organism of vaccine, the potency of the specific germ was injuriously affected. Such action was shown by methyl alcohol, acrolein, oxalic acid, and lactic acid.

3. Some substances, such as ammonia, monoacetin, diacetin, triacetin, hydrogen peroxide, and others, have allowed extensive growth of some extraneous micro-organisms, while the potency of the specific germ has been destroyed by their influence.

4. Several substances have shown marked germicidal action on the extraneous micro-organism of vaccine, with the exception of *bacillus mesentericus*, but apparently caused no injury to the potency of the specific virus. In some cases this germicidal action has been approximately as rapid as that of glycerine, while in others it

has been considerably more rapid, and in all cases potency has been retained for as long a period under these experimental substances as under the control glycerine.

In this elimination of extraneous bacteria it is noticeable that all organisms of the same species in any one vaccine have by no means an equal resistance to the same germicidal influence. Such variation is evident whether the germicidal action is comparatively rapid or slow. Whatever the explanation of this variation of resistance may be, one is led to wonder, in the case of very slow decrease in numbers of a species, where the process may perhaps occupy months, how much elimination is due to germicidal action and how much to natural death of individual bacteria.

The following table shows the substances which have, in the present experiments, been found to possess a "selective" germicidal influence on the micro-organisms of vaccine; that is to say, which have eliminated the extraneous organisms and allowed the specific germ to retain their potency so that well developed vesicles resulted from their inoculation on calves. These substances are arranged according to their respective rates of action, which are also recorded :—

Chemical Substance.	Strength of Aqueous Solution.	Approximate Time of Elimination of Extraneous Micro-organisms.		Potent at	
		Experimental Vaccine.	Control.	Experimental Vaccine.	Control.
Eucalyptol ..	1-200	7 weeks	7 weeks	2 months	2 months
Peppermint ..	1-200	7 weeks	7 weeks	2 months	2 months
Saccharine ..	Saturation.	7 weeks	7 weeks	2 months	2 months
Glycocoll	—	7 weeks	7 weeks	2 months	2 months
Boracic Acid ..	Saturation.	4 weeks	7 weeks	6 weeks	6 weeks
Biborate of Soda	Saturation.	4 weeks	7 weeks	6 weeks	6 weeks
Isobutyl Alcohol	Saturation.	1-4 weeks	7 weeks	1 month	1 month
Propylene Glycol	5-10 °/o	1-4 weeks	7 weeks	2 months	2 months
Carbolic Acid ..	1-100	1 week	7 weeks	2 months	2 months
Carbolic Acid and Glycerine.	1-100	24 hours	7 weeks	2 months	2 months
Chloroform ..	1-200	6 hours	7 weeks	5 months	5 months

Thus ten substances, not including several carbo-hydrates mentioned in last year's experiments, exert a germicidal action on the extraneous bacteria of vaccine, and apparently little or no harmful influence on the potency of its specific germ.

Of these substances, four—eucalyptol, peppermint, saccharine, and glycocoll—have shown approximately the same rate of germicidal action as glycerine; two—biborate of soda and boracic acid

APP. C, No. 8.

The action of Chloroform and other substances on Micro-Organisms of Vaccine; by Dr. Green.

—are slightly quicker in action than glycerine; two—isobutyl alcohol and propylene glycol—are markedly quicker; one substance—carbolic acid—practically eliminated extraneous organisms in one week, while a corresponding elimination occupied seven weeks in the glycerine control. Chloroform water eliminated extraneous organisms in about six hours, as against seven weeks of the glycerine of the control, while the resulting vesicles were always as well developed as those due to the controls.

Thus, the eliminating action of chloroform is even more rapid than was apparent last year, and this germicide, especially as it can be removed by evaporation from vaccines at any time, promises to be of the greatest service in their preparation. As regards this point it is hoped that further tests will enable a definite statement to be made in a future Report.

Quite lately I have devised another method of treating vaccines with chloroform which so far has given very satisfactory results. Roughly, this method consists of passing a mixture of *chloroform vapour* and air through vaccines previously mixed either with distilled water or with distilled water and glycerine solution. In this way elimination of extraneous micro-organisms is found to be as complete, and in point of time more rapid, than by former chloroform methods, while the specific germ remains fully active.

A further account of this method, and the results obtained by its use, will be given in the next Report of the Medical Officer.

PLATE I.

FIG. 1. FIG. 2.

FIG. 3.

FIG. 4.

FIG. 5.

ANAËROBIC MICROBES.

PLATE I.

FIGS. 1 and 2.

Two culture tubes—slanting surface of gelatine—which had been inoculated, in streaks, with B. enteritidis sporogenes—left, and with B. butyricus—right, and then incubated anaërobically. The B. enteritidis sporogenes formed copious growth softening and liquefying the gelatine, whereas the B. butyricus produced small flat colonies with no tendency whatever of liquefying the gelatine.

[Natural size.]

FIG. 3.

A mass of thready flat growth of former culture tube of B. butyricus, showing numerous threads in bundles making up the growth.

[Magnifying power, 14.]

FIG. 4.

From a stab culture in gelatine of B. enteritidis sporogenes, showing no thready outgrowths.

[Magnifying power, 2½.]

FIG. 5.

From a stab culture in gelatine of B. butyricus, showing characteristic filamentous outgrowths.

[Magnifying power, 2½.]

HÆMORRHAGIC SMALL-POX.

PLATE II.

FIG. 1.

Film specimen of blood from the right ventricle of Nurse T., dead 9th December, showing numerous capsulated diplococci.

[Magnifying power, 1,000.]

FIG. 2.

Exudation at the seat of inoculation in a mouse, dead after subcutaneous inoculation with culture of the above capsulated diplococcus.

[Magnifying power, 1,000.]

PLATE II.

Fig. 1.

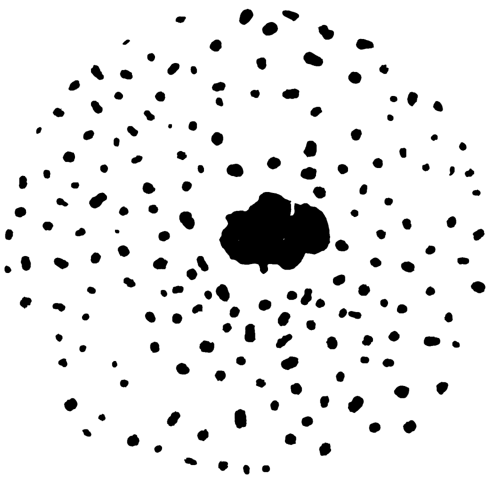

Fig. 2.

PLATE III.

Fig. 3.

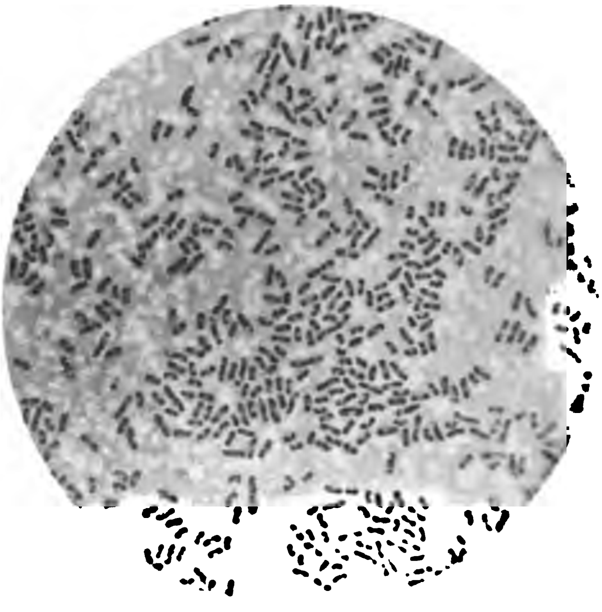

Fig. 4.

HÆMORRHAGIC SMALL-POX.

PLATE III.

FIG. 3.

From a pure culture of the bacterium myxoides (from Nurse T.'s blood), showing a zoogloea of the (bipolar) plague like bacilli.

[Magnifying power, 1,000.]

FIG. 4.

Film specimen of the viscid peritoneal exudation of a guinea-pig, dead after intraperitoneal injection of B. myxoides.

[Magnifying power, 1,000.]

HÆMORRHAGIC SMALL-POX.

PLATE IV.

FIGS. 5 and 6.

Specimens of heart's blood of a guinea-pig, dead after intra-peritoneal injection with B. myxoides, showing great numbers of the bipolar bacilli.

[Magnifying power, 1,000.]

PLATE IV.

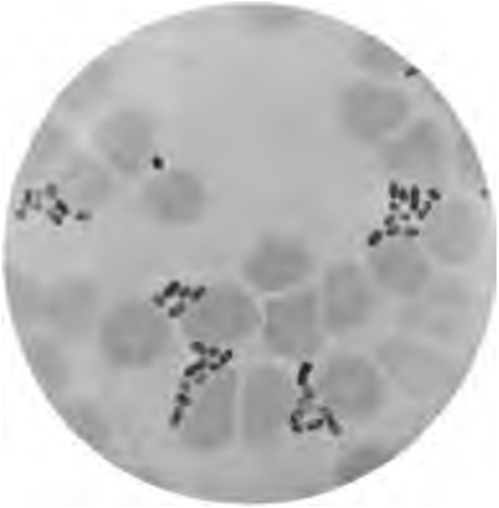

Fig. 5.

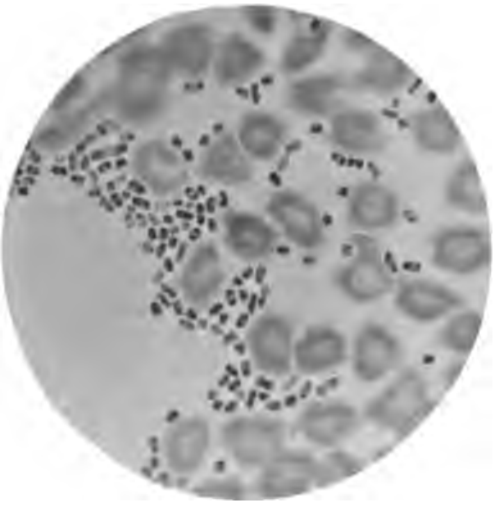

Fig. 6.

PLATE V.

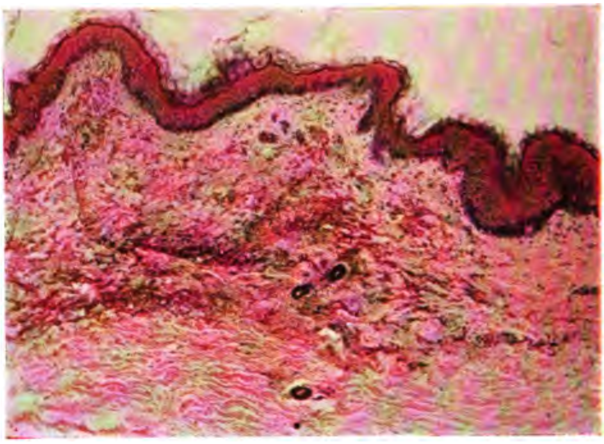

FIG. 7.

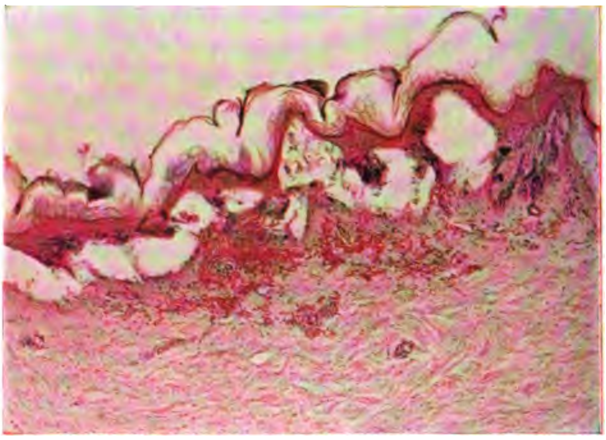

FIG. 8.

HÆMORRHAGIC SMALL-POX.

PLATE V.

FIG. 7.

Section through a hæmorrhagic area of the skin of Nurse T.

Here, the epidermis (blue) appears quite unchanged; the deeper part of the corium contains masses of blood (pink) effused and extravasated into the interfascicular lymph channels. The corium, however, of the papillary body is free of such blood.

[Magnifying power, 65.]

FIG. 8.

Section through the hæmorrhagic eruption on the skin of a typical case of hæmorrhagic variola.

Here, the stratum malphigii in its deeper layers contains the loculated vesicle partly filled with blood (pink); immediately under the vesicle in the papillary part of the corium there is much extravasated blood. The deeper part of the corium is, however, free of any change.

[Magnifying power, 65.]

B. DIPHTHERIÆ.

PLATE VI.

FIG. 1.

Four serum cultures each inoculated with approximately $\frac{1}{100,000}$ cc. of mucus from the throat of a patient suffering from diphtheria. The cultures have been incubated for 4 days at 37° C. The raised well-defined colonies present in each case are colonies of B. diphtheriæ.

FIG. 2.

An agar culture inoculated with a dilution of the nasal discharge of acute coryza, and incubated for 4 days at 37° C. The large colonies are formed by a coccus and by Hoffmann's bacillus. The minute colonies, in the majority, are colonies of B. coryzæ segmentosus.

FIG. 3.

A cover-glass preparation made from the nasal discharge of a case of acute coryza or ordinary "cold in the head," and stained with Löffler's methylene blue. A small group of bacilli and two diplococci are seen.

[Magnifying power, 1,000.]

PLATE VI.

Fig. 1.

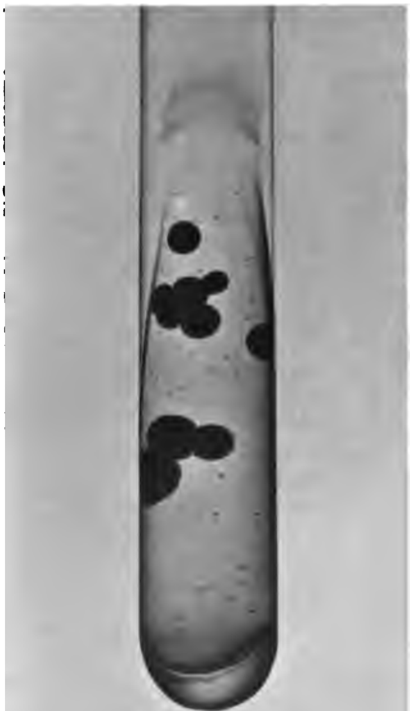

Fig. 2.

Fig. 3.

PLATE VII.

FIG. 4.

FIG. 6.

FIG. 5.

B. DIPHTHERIÆ.

PLATE VII.

[Figures 4–15 inclusive are all preparations made from serum cultures after 18 hours' growth at 37° C. The stain in all cases was Löffler's methylene blue. The magnification in all cases is 1,000 diameters.]

FIG 4.

B. diphtheriæ.

FIG. 5.

Another specimen of B. diphtheriæ.

FIG. 6.

Micro-organism No. 2 of the series not possessing all the characters of B. diphtherine. This organism was not identified with B. Diphtheriæ.

B. DIPHTHERIÆ.

PLATE VIII.

[*See* note to Plate VII.]

Fig. 7.

Micro-organism No. 3 of the same series. This organism was chromogenic.

Fig. 8.

Micro-organism No. 4 of the same series. B. coryzæ segmentosus.

Fig. 9.

Another specimen of B. coryzæ segmentosus.

PLATE VIII.

Fig. 7.

Fig. 8.

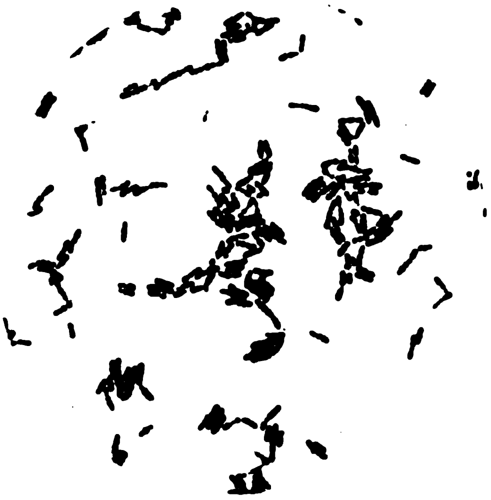

Fig. 9.

PLATE IX.

Fig. 10.

Fig. 11.

Fig. 12.

B. DIPHTHERIÆ.

PLATE IX.

[*See* note to Plate VII.]

FIG. 10.

Micro-organism No. 5 of the same series. Hoffmann's bacillus isolated from the nasal discharge of acute coryza.

FIG. 11.

Another specimen of Hoffmann's bacillus isolated from the throat of a case of suspected diphtheria.

FIG. 12.

Micro-organism No. 6 of the same series.

B. DIPHTHERIÆ.

PLATE X.

[*See* note to Plate VII.]

Fig. 13.

Micro-organism No. 7 of the same series.

Fig. 14.

Micro-organism No. 8 of the same series. This field was found with difficulty as in the majority of the preparation the organism was very conglomerate.

Fig. 15.

Micro-organism No. 9 of the same series.

PLATE X.

Fig. 13.

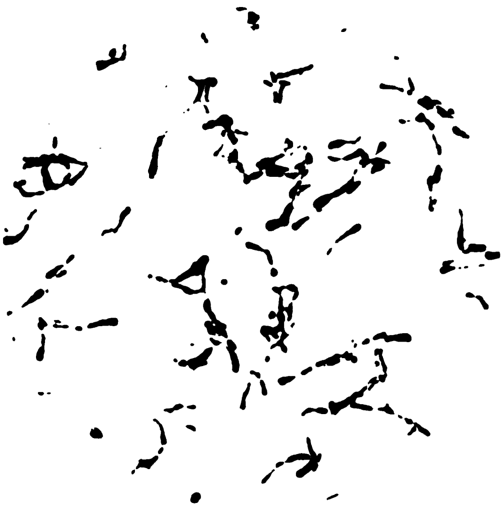

Fig. 14.

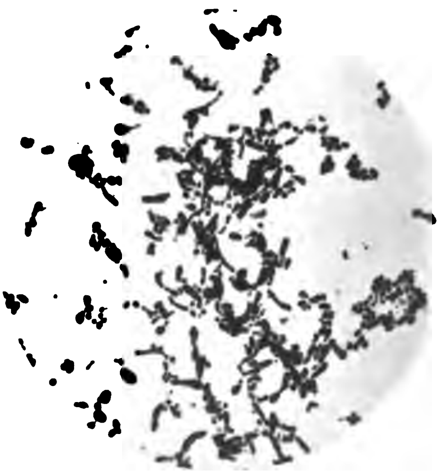

Fig. 15.

PLATE XI.

FIG. 16.

FIG. 17.

B. DIPHTHERIÆ.

PLATE XI.

FIG. 16.

The same specimen of B. diphtheriæ as seen in Fig. 4. Neisser's stain and lightly counterstained with dilute carbol fuchsine. Note the granules.

[Magnifying power, 1,000.]

FIG. 17.

Micro-organism No. 10 of the series not possessing all the characters of B. diphtheriæ. Agar growth one day. Neisser's stain and lightly counterstained with dilute carbol fuchsine. Note the granules.

[Magnifying power, 1,000.]

B. DIPHTHERIÆ.

PLATE XII.

Agglutination tests. Photographs showing the condition of preparations after one hour's contact. All magnified 500 diameters.

Fig. 18.

Emulsion of B. diphtheriæ and Hoffmann guinea-pig's blood. No clumping.

Fig. 19.

The same emulsion and diphtheria guinea-pig's blood. Clumping.

Fig. 20.

Emulsion of Hoffmann's bacillus and the same diphtheria guinea-pig's blood as in Fig. 19. No clumping.

Fig. 21.

The same emulsion and the Hoffmann guinea-pig's blood as in Fig. 18. Clumping.

PLATE XII.

FIG. 18.

FIG. 19.

FIG. 20.

FIG. 21.

PLATE XIII.

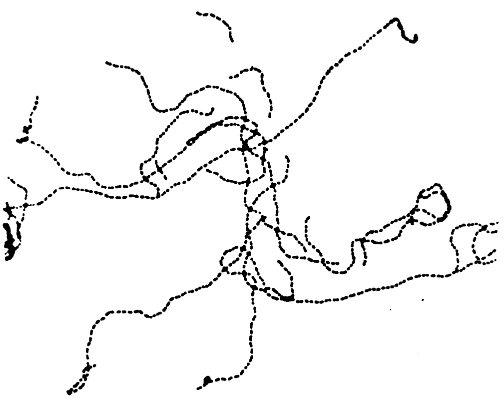

FIG. 1

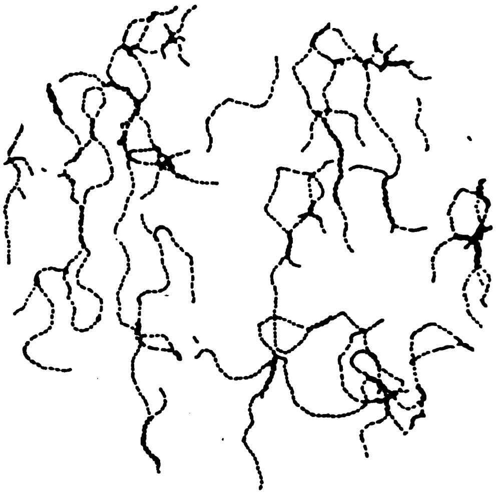

FIG. 2.

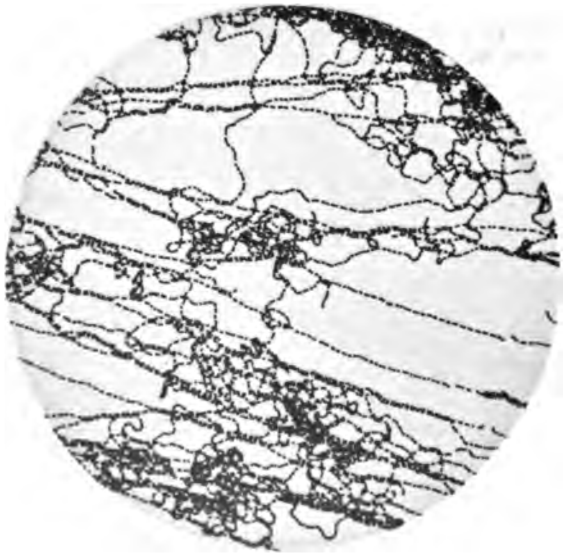

FIG. 3.

BACTERIA IN SEWAGE CONTAMINATED SOIL.

PLATE XIII.

FIG. 1.

Microscopic preparation from a broth culture of Streptococcus 1; stained with weak carbol fuchsin. (Soil I., Part I.)

[Magnifying power, 500.]

FIG. 2.

Microscopic preparation from a broth culture of Streptococcus 2; stained with weak carbol fuchsin. (Soil I., Part I.)

[Magnifying power, 500.]

FIG. 3.

Microscopic preparation from a broth culture of Streptococcus 3; stained with weak carbol fuchsin. (Soil A^3, Part II.)

[Magnifying power, 500.]

To illustrate Mr. H. S. FREMLIN'S paper, "On the INFLUENCE of ANAËROBIC CONDITIONS on the EXTRANEOUS ORGANISMS of GLYCERINATED CALF LYMPH," which appeared in the Report of the Medical Officer to the Local Government Board, 1900–1901.

PLATE XIV.

FIG. 1.

The photograph of an original agar-agar plate inoculated with one platinum loopful of freshly prepared glycerinated calf lymph, and incubated under *anaërobic* conditions for 48 hours at 37° C., and for seven days further at room temperature.

FIG. 2.

The photograph of the control agar-agar plate of that represented in Fig. 1. This control plate was incubated under *aërobic* conditions. The number of colonies in the two plates correspond very closely.

PLATE XIV.

FIG. 1.

FIG. 2.

PLATE XV.

FIG. 1.

FIG. 2.

To illustrate Dr. F. R. BLAXALL'S paper, "The EFFECT of HEAT on the ACTIVITY of CRUDE CALF LYMPH, and on the CONTAINED EXTRANEOUS ORGANISMS," which appeared in the Report of the Medical Officer to the Local Government Board, 1900–1901.

PLATE XV.

FIG. 1.

The photograph of an agar-agar plate, showing the number of extraneous micro-organisms present in one platinum loopful of a freshly prepared mixture of vaccine vesicles and distilled water, *before* exposure of the mixture to a temperature of 57·5° C. for five minutes.

FIG. 2.

The photograph of an agar-agar plate, showing the number of extraneous micro-organisms present in one platinum loopful of the same mixture *after* exposure to a temperature of 57·5° C. for five minutes.

This plate shows the great reduction in number of extraneous micro-organisms which had taken place after such exposure.

To illustrate Dr. F. R. BLAXALL'S paper, "The EFFECT of HEAT on the ACTIVITY of CRUDE CALF LYMPH, and on the CONTAINED EXTRANEOUS ORGANISMS," which appeared in the Report of the Medical Officer to the Local Government Board, 1900–1901.

PLATE XVI.

FIG. 3.

The photograph of an agar-agar plate, showing the number of extraneous micro-organisms present in one platinum loopful of a freshly prepared mixture of vaccine vesicles and distilled water, *before* exposure of the mixture to a temperature of 57·5° C. for five minutes.

FIG. 4.

The photograph of an agar-agar plate, showing the number of extraneous micro-organisms present in one platinum loopful of the same mixture *after* exposure to a temperature of 57·5° C. for five minutes.

This plate shows the great reduction in number of extraneous micro-organisms which had taken place after such exposure.

PLATE XVI.

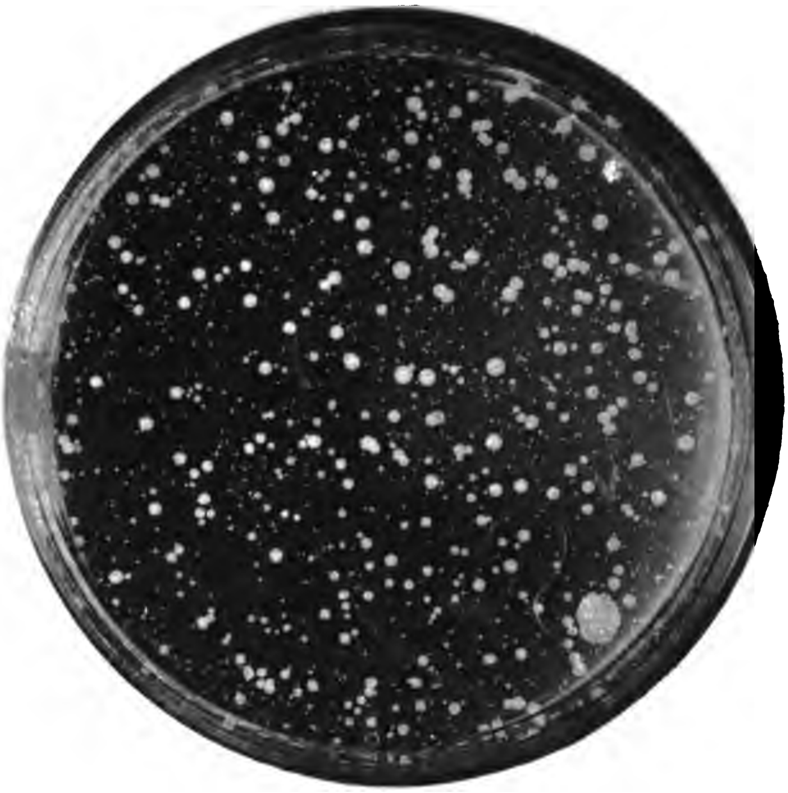

Fig. 3.

Fig. 4.

PLATE XVII.

Fig. 1.

Fig. 2.

The ELIMINATION of EXTRANEOUS BACTERIA from CALF VACCINE by means of CHLOROFORM WATER, compared with the ELIMINATION of EXTRANEOUS BACTERIA from CALF VACCINE by means of GLYCERINE.

PLATE XVII.

FIG. 1.

The photograph of an agar-agar plate culture, showing the number of colonies of extraneous bacteria present in one platinum loopful of vaccine emulsion, *at the time of* mixture of the vaccine with four times its own weight of a saturated solution of chloroform water.

FIG. 2.

The photograph of an agar-agar plate culture, showing the number of colonies of extraneous bacteria present in one platinum loopful of the same chloroformed vaccine emulsion *half an hour after* mixture.

The ELIMINATION of EXTRANEOUS BACTERIA from CALF VACCINE by means of CHLOROFORM WATER, compared with the ELIMINATION of EXTRANEOUS BACTERIA from CALF VACCINE by means of GLYCERINE.

PLATE XVIII.

FIG. 3.

The photograph of an agar-agar plate culture, showing the number of colonies of extraneous bacteria present in one platinum loopful of the same chloroformed vaccine emulsion *one hour after* mixture.

FIG. 4.

The photograph of an agar-agar plate culture, showing the number of colonies of extraneous bacteria present in one platinum loopful of the same chloroformed vaccine emulsion *one and a half hours after* mixture.

PLATE XVIII.

FIG. 3.

FIG. 4.

PLATE XIX.

Fig. 5.

Fig. 6.

The ELIMINATION of EXTRANEOUS BACTERIA from CALF VACCINE by means of CHLOROFORM WATER, compared with the ELIMINATION of EXTRANEOUS BACTERIA from CALF VACCINE by means of GLYCERINE.

PLATE XIX.

FIG. 5.

The photograph of an agar-agar plate culture, showing the number of colonies of extraneous bacteria present in one platinum loopful of the same choroformed vaccine emulsion *two hours after* mixture.

FIG. 6

The photograph of an agar-agar plate culture, showing the number of colonies of extraneous bacteria present in one platinum loopful of the same chloroformed vaccine emulsion *two and a half hours after* mixture.

The ELIMINATION of EXTRANEOUS BACTERIA from CALF VACCINE by means of CHLOROFORM WATER, compared with the ELIMINATION of EXTRANEOUS BACTERIA from CALF VACCINE by means of GLYCERINE.

PLATE XX.

FIG. 7.

The photograph of an agar-agar plate culture, showing the number of colonies of extraneous bacteria present in one platinum loopful of the same chloroformed vaccine emulsion *three hours after* mixture.

FIG. 8.

The photograph of an agar-agar plate culture, showing the number of colonies of extraneous bacteria present in one platinum loopful of the same chloroformed vaccine emulsion *three and a half hours after* mixture.

PLATE XX.

FIG. 7.

FIG. 8.

PLATE XXI.

Fig. 9.

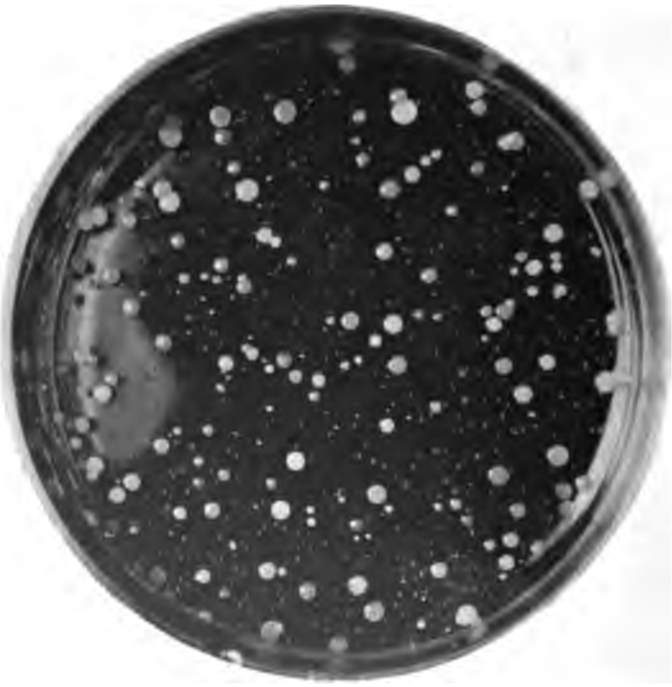

Fig. 10.

The ELIMINATION of EXTRANEOUS BACTERIA from CALF VACCINE by means of CHLOROFORM WATER, compared with the ELIMINATION of EXTRANEOUS BACTERIA from CALF VACCINE by means of GLYCERINE.

PLATE XXI.

FIG. 9.

The photograph of an agar-agar plate culture inoculated with one platinum loopful of the same *chloroformed vaccine emulsion four hours after* mixture, and incubated in the same manner as the foregoing agar-agar plate culture. No growth of extraneous bacteria occurred on this plate.

FIG. 10.

The photograph of an agar-agar plate culture, showing the number of colonies of extraneous bacteria still present in one platinum loopful of the *control glycerinated vaccine emulsion* at the end of the *first week after* mixture.

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OF

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1901–1902.

SUPPLEMENT

CONTAINING THE

REPORT OF THE MEDICAL OFFICER

For 1901–02.

Presented to both Houses of Parliament by Command of His Majesty.

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